PROCEEDINGS OF THE

Twenty-Eighth Annual Convention

OF THE

American Railway Bridge and Building Association

HELD AT

CHICAGO, ILL.

October 15-17, 1918

REPORTS IN THIS ISSUE

Repairing and Strengthening Old Masonry
Sources of Water Supply
Wooden Tanks
Bridge Decks and Guards
Shipping Material Economically
Essential Work
Carrying Bridges Over
Labor Saving Devices
Factory Made Concrete
Conservation of Material
Small versus Large Gangs

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PUBLISHED BY THE ASSOCIATION
C. A. Lichty, Secretary
319 NO. WALLER AVENUE
CHICAGO, ILL.

MASSEY CONCRETE PRODUCTS CORPORATION

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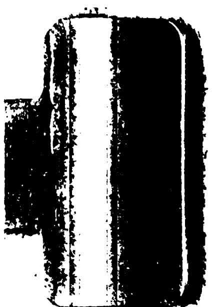

To Our B. & B. Friends :-

For years the C. F. Massey Company has been supplying you with pipe, wells, houses and other reinforced concrete railway supplies. Your approval of our product is evidenced by ever increasing orders. Your interest in our company is shown by the many suggestions and requests for data we receive. You will, therefore, be interested to know that the C. F. Massey Company and the Universal Concrete Products Company will henceforth be known as the Massey Concrete Products Corporation, with general offices as before, in the Peoples Gas Building, Chicago.

MASSEY CONCRETE PRODUCTS CORPORATION

LEE JUTTON
Division Engineer, C. & N. W. Ry.,
President, 1919

CALVIN A. LICHTY
Secretary-Treasurer

PROCEEDINGS OF THE

Twenty-Eighth Annual Convention

OF THE

American Railway Bridge and Building Association

Successor to the

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS

HELD AT

CHICAGO, ILL.

OCTOBER 15-17, 1918

Official Badge

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1918

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Methods and Equipment Used in Renewing Timber Bridges.

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E. E. Clothier, C. M. & St. P. Ry., Mobridge, S. D.
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A. B. Nies, M. C. R. R., Jackson, Mich.
P. J. O'Neill, N. Y. C. R. R., Adrian, Mich.

Methods of Bridge Inspection Under Present Conditions.

Arthur Ridgway, D. & R. G. R. R., Denver, Colo.
J. H. Johnston, G. T. R., Montreal, Que.
Herbert Keith, 13 Park Row, New York, N. Y.
G. W. Rear, S. P. Co., San Francisco, Cal.
J. L. Winter, S. A. L. Ry., Waldo, Fla.
J. S. Huntoon, M. C. R. R., Detroit, Mich.

Economical Use and Storage of Fuel at Railway Pumping Stations.

F. M. Case, C. & N. W. Ry., Belle Plaine, Iowa.
C. R. Knowles, I. C. R. R., Chicago, Ill.
E. A. Demars, O. S. L. R. R., Salt Lake City, Utah.
A. D. McCallum, C. H. & D. R. R., Hamilton, O.

Painting Metal Railroad Structures.

C. T. Musgrave, O. S. L. R. R., Idaho Falls, Idaho.
Chas. Ettinger, I. C. R. R., Chicago, Ill.
E. S. Airmet, O. S. L. R. R., Salt Lake City, Utah.
Fred Gaunt, O. S. L. R. R., Pocatello, Idaho.
B. D. Rich, S. P. Co., Stockton, Cal.
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Tools.

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B. F. Ferris, Sou. Pac. Co., Portland, Ore.
A. H. King, O. S. L. R. R., Pocatello, Idaho.
W. S. Batey, U. P. R. R., Kansas City, Mo.

Paper on Railway Fire Protection Equipment.

C. R. Knowles, Supt. Water Service, I. C. R. R., Chicago, Ill.

COMMITTEES

Membership

H. A. Horning, M. C. R. R., Jackson, Mich.
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Nominations

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S. C. Tanner, B. & O. R. R., Baltimore, Md.
Arthur Montzheimer, E. J. & E. Ry., Joliet, Ill.

Subjects

O. F. Dalstrom, C. & N. W. Ry., Chicago, Ill.
J. B. Gaut, M. C. R. R., Detroit, Mich.
Chas. Ettinger, I. C. R. R., Chicago, Ill.

Publications

R. C. Sattley, C. R. I. & P. Ry., Chicago, Ill.
C. F. Womeldorf, C. & N. W. Ry., Chicago, Ill.
P. Aagaard, Ill. Cent. R. R., Chicago, Ill.

Arrangements

R. H. Reid, N. Y. C. R. R., Cleveland, O.
W. L. Rohbock, W. & L. E. R. R., Cleveland, O
F. C. Osborn, 2848 Prospect Ave., Cleveland, O.

Relief

C. R. Knowles, I. C. R. R., Chicago, Ill.
A. H. King, O. S. L. R. R., Pocatello, Idaho.
Geo. W. Rear, S. P. Co., San Francisco, Cal

Obituary

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J. P. Wood, P. M. R. R., Saginaw, Mich.

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(Followed by Discussion)

Proceedings of the Twenty-eighth Annual Convention
of the

American Railway Bridge and Building Association

Held at the Hotel Sherman

Chicago, Ill., October 15-17, 1918

The twenty-eighth annual convention of the American Railway Bridge and Building Association was called to order in the Louis XVI room of the Hotel Sherman, Chicago, at 10:30 o'clock Tuesday, October 15, 1918, by President S. C. Tanner.

The President:—Following the established custom we will open the meeting with prayer. I will call on the secretary to offer prayer.

Invocation by Secretary Lichty.

The President:—It has been customary to have an address of welcome by the mayor of the city and from some prominent railroad man, followed by a response from one of our members, and while this was interesting and entertaining it was thought best to dispense with such items during the war. Conditions are different from what they were several years ago and instead of "talk and entertain" it is now "business and action." We have therefore decided to cut out at this time all matters of entertainment. Business will predominate in these sessions and we will cut the preliminaries short.

It has been the custom to have an address from the president and he has deemed it wise to cut this to a minimum and "clear the deck for action."

I do not want to allow the opportunity to pass without commenting on the attendance, which, although not as large as in other recent years, is fully as good or better than we could expect, all

things considered. It shows the loyalty of our members to the National Government and to the railroads which we represent. Your attendance at these meetings is an indication of patriotism because you come to spread broadcast knowledge pertaining to the best and most economical methods of practice pertaining to the construction and maintenance of railroad bridges, buildings and water supply.

I believe I am safe in saying, and that you will agree with me, that the railroads are the fathers of industry in this country and that the tracks, bridges and buildings are the grandparents of the railroads. It is almost impossible to comprehend the great importance and value of the 252,000 miles of the railroads to our Government and our allies at the present time in transporting troops, munitions and supplies. Our members are vitally interested in maintaining the roads in the best possible shape, both in this country and abroad, and this is much more difficult at the present time on account of the scarcity of labor and materials which confronts us on every hand in all parts of the country. It is therefore proper that we should meet and discuss these matters which pertain to the conservation of labor and material and to recommend methods of saving labor and all manner of mechanical labor saving devices. (Applause.)

We will now proceed with the regular order of business.

The reading of the minutes of the previous meeting will be dispensed with as they have been published and placed in the hands of all the members. The report of the executive committee will also be dispensed with for the same reason. The next in order is roll call.

The Secretary:—Most of you are familiar with the method we use to secure the registration of members present at the convention. Registration cards are to be found at the desk just outside the door. We urge all present to register in order that we may be able to show the full attendance.

The registration showed the following members to be present:

P. Aagaard	R. J. Bruce	W. L. Derr
W. E. Alexander	J. M. Caldwell	J. Dupree
L. J. Anderson	W. M. Camp	C. H. Eggers
S. D. Bailey	F. M. Case	Chas. Esping
F. C. Baluss	E. E. Clothier	Chas. Ettinger
H. Bender	E. Collings	R. F. Farlow
M. Bishop	F. J. Conn	W. H. Finley
S. C. Bowers	John Cronin	M. J. Flynn
G. U. Boyer	O. F. Dalstrom	B. F. Gehr
Geo. E. Brooks	E. A. Demars	Ira Gentis

H. A. Gerst
Chas. Gradt
F. N. Graham
Edw. Guild
L. D. Hadwen
Thos. Hall
A. W. Harlow
R. C. Henderson
H. A. Horning
Wm. B. Hotson
E. T. Howson
J. Hunciker
J. S. Huntoon
W. J. Jackson
A. J. James
Nels Johnson
Lee Jutton
C. W. Kelly
A. H. King
C. R. Knowles
G. W. Land
T. S. Leake
E. R. Lewis
C. A. Lichty
M. Loeffler
Geo. Loughnane
A. S. Markley
E. M. McCabe
Edward McGuire
R. McKibben
A. McNab
J. W. Miller
M. D. Miller
L. A. Mitchell
A. Montzheimer
R. E. Murphy
G. K. Nuss
P. J. O'Neill
J. F. Parker
K. Peabody
J. A. S. Redfield
R. H. Reid
H. Rettinghouse
G. S. Richards
R. W. Richardson
M. Riney
J. S. Robinson
W. A. Rogers
D. Rounseville
R. C. Sattley
F. E. Schall
C. J. Scribner
L. T. Seeley
A. C. Shields
I. L. Simmons
R. W. Smith
Jos. Spencer
W. M. Sterling
H. B. Stuart
Wm. Sullivan
O. M. Suter
H. C. Swartz
W. M. Sweeney
P. Swenson
S. C. Tanner
D. B. Taylor
M. E. Thomas
E. E. R. Tratman
T. B. Turnbull
C. G. Vollmer
H. von Schrenk
C. F. Warcup
F. E. Weise
J. B. White
M. R. Williams
A. A. Wolf
C. F. Womeldorf
J. P. Wood
J. W. Wood
A. Yappen

The following persons subsequently elected to membership were also present:

C. N. Bainbridge
W. A. Batey
F. A. Eskridge
Wm. James
Geo. F. Porter
F. H. Soothill
T. G. Sughrue
R. Kendall
A. C. Roberts

Total number of members registered, 119.

The past presidents in attendance were A. S. Markley, W. A. Rogers, A. Montzheimer, C. A. Lichty, R. H. Reid, H. Rettinghouse, F. E. Schall, and L. D. Hadwen.

The President:—I will appoint F. E. Weise assistant secretary for the duration of the convention.

We will now have the report of the secretary-treasurer.

REPORT OF THE SECRETARY-TREASURER

There is no doubt but that the Association is passing through the most strenuous period in its history. Labor conditions on the railroads are the reverse of what they had been for many years past and at the present time the question of help is the source of a great deal of worry to those who have the hiring of men of nearly all classes. Many of our members who have been regular in attendance at our conventions in past years are unable to be present at this meeting on account of the depletion of their forces, making it necessary for them to remain in close proximity to their work.

Several of our members are engaged in active military service; a number of others are in the vicinity of Washington or in the various shipbuilding yards all along the coast. Many of our members have given up good positions to offer their services to the nation. The man

who so ably presided at our convention last year (in this room) turned his fine engineering practice over to others and is now a major in the national service. We have from among our members a number of majors, two lieutenant colonels and others of lesser rank in the service.

Our association has received favorable consideration from the railroad administration and we have not been handicapped in any manner in carrying out our work which we deem so important at this time to our members, our fellow workmen and the railroads which we represent. Everything considered, it may be said that our association is in a healthy and prosperous condition. Our membership is keeping up fully as well as could be expected, yet it is true that there are many large roads from which we have no representatives and others from which we have only one or two. Our members are keeping up their dues fully as well as in other years. Our dues have not been raised and while for several years past we have not kept even,—gradually reducing our surplus in the treasury—we are able this year to show a balance on the right side of the ledger. We have perhaps the lightest dues of any similar organization in the country and if our members will pay up promptly in the future it may not become necessary to increase them while we will also be enabled to meet our obligations without drawing on our reserve which is now in the vicinity of $900. It is gratifying to know that many of our old members who have attained the highest ranks in railroad service "stand by the old ship" and continue to say words of praise for the work accomplished by the association. While most of us are doing our "bit" many are doing their best,—in committee work, soliciting new members, securing advertisements or perhaps speaking a good word here and there for the association wherever and whenever they can. It is impossible for the secretary and the other officers to carry the entire load and make the outcome a success.

While we have not received notice of any fatalities among those who are engaged in military service the grim reaper has been busy in our ranks and our roll has suffered the loss of eleven members by death, due recognition of which will be made by the obituary committee as well as by the publication of fitting memoirs in our proceedings each year where the information is available.

A separate memorial volume of 93 pages was published and distributed during the past year on the life of the lamented "Deacon" S. F. Patterson who was perhaps the most unique character in the history of the association. Further reference will be made by the special memorial committee.

Upon the action of the convention at its meeting a year ago congratulations were sent to our member, Mr. Phelps Johnson, president of the St. Lawrence Bridge Co., upon the successful completion of the world's greatest bridge at Quebec in reply to which a letter of appreciation was received which will appear in the minutes of this convention.

The regular number of copies of the proceedings of the last meeting (1200) was published and distributed,—800 copies being bound in cloth and 400 in paper covers.

It has been the custom in the past to furnish the leading libraries of cities and colleges with our publications and this custom is still in vogue.

The financial report follows:

Chicago, October 14, 1918.

Financial

Balance on hand at last report ....$ 957.79

Receipts

Dues and fees	$1,159.00	
Advertising	1,203.60	
Sale of badges	7.25	
Sale of books	21.55	
Interest	48.00	
Total receipts		$2,439.40
Total on hand and received		$3,397.19

Disbursements

Postage	$ 121.35	
Printing and engraving	1,191.47	
Stationery and office supplies	21.85	
Editing	70.00	
Stenographer	90.00	
Expenses various committees	6.00	
Badges	11.73	
Salaries and office rent	800.00	
Convention expenses	22.70	
Telephone and telegraph	2.30	
Miscellaneous	16.00	
Total disbursements		$2,353.40
Balance on hand Oct. 14, 1918		$1,043.79

Of the above amount $800 has been loaned out on first mortgage notes at 6 per cent and the balance of $243.79 is on hand in the bank.

Respectfully submitted, C. A. Lichty, Secy-Treas.

The report was accepted and the president appointed R. C. Sattley, J. S. Robinson and M. Riney to audit the books and accounts of the secretary-treasurer. The president also appointed a committee on resolutions consisting of F. E. Schall, J. P. Wood, and P. J. O'Neill. Several announcements were made, after which the ladies were permitted to retire from the hall.

The President:—We will now have the report of the committee on membership.

REPORT OF MEMBERSHIP COMMITTEE

During the year a circular letter was issued similar to the one used last year which was sent out with application blanks. The committee received very good support from individual members and new members were secured from all parts of the country. A great deal can yet be done in securing new members for there are several large railroads which have few or no representatives in the association.

Despite the fact that it was a difficult year, for many reasons, to get new members the committee is able to submit for your approval the attached list of 48 applicants.

E. M. McCabe,
N. C. Ailes,
A. W. Reynolds,
J. K. Bouner,
A. H. King,
Committee.

LIST OF APPLICANTS FOR MEMBERSHIP

Alexander, S. Y., Gen. For. B. & B., St. L. B. & M., Kingsville, Tex.
Bainbridge, C. N., Asst. Engr., C. M. & St. P., Chicago.
Batey, W. A. Supv. B. & B., U. P., Kansas City, Mo.
Bennett, D. E., For. B. & B., Mo. Pac., De Soto, Mo.
Busier, T. W., Plumb. For., B. & A., Pittsfield, Mass.
Caldwell, C. H., For. B. & B., Sou. Pac., E. Bakersfield, Cal.
Colclough, E., Gen. For. B. & B., A. T. & S. F., Fresno, Cal.
Creeks, J. L., For. B. & B., Sou. Pac., Dunsmuir, Cal.
Curry, Jno., For. B. & B., Mo. Pac., McGehee, Ark.
de Ximeno, A., C. C. S. C., Obispo 59 altos, Havana, Cuba.
Dillabough, J. V., Asst. Dist. Eng., C. N. Edmonton, Alberta.
Eskridge, F. A., Archt., C. & E. I., Chicago, Ill.
Frazer, H. H., Div. For. W. & F. Service, S. P., Dunsmuir, Cal.
Golson, W. P., Roadmaster, C. of Ga., Macon, Ga.
Griffith, W. J., Mas. For., B. & A., Pittsfield, Mass.
Haag, Orin, Carp. For., B. & O., Garrett, Ind.
Hartwell, J. R., Supv., P. R. C. & N. W., Pierre, S. D.
Harvey, T. J., Br. Insp., B. & A., Pittsfield, Mass.
Hillman, F. W., Div. Engr., C. & N. W., Madison, Wis.
James, Wm., Carp. For., I. C., New Orleans, La.
Kendall, R., Mast. Carp., C. & W. I., Chicago.
Little, C. A., Div. For. B. & B., B. & M., Concord, N. H.
McMahon, G., For. B. & B., Sou. Pac., Dunsmuir, Cal.
McMahon, Thos. D., Archt., G. N., St. Paul, Minn.
May, Frank, For. B. & B., Mo. Pac., Charleston, Mo.
Moore, C. J., Mast. Carp., St. L. S. W., Pine Bluff, Ark.
Moreau, C. L., Gen. For., B. & A., Springfield, Mass.
Morin, T., Br. For., B. & A., Pittsfield, Mass.
O'Connell, J., Ptr. For., B. & A., Pittsfield, Mass.
Oetzman, E., Gen. For. W. S., A. T. & S. F., Fresno, Cal.
Paul, C. E., Prof. Mechanics, Armour Inst. Technology, Chicago.
Porter, G. F., Engr. Const., St. L. Br. Co., Montreal, Que.
Porter, J. W., Ch. Engr., H. B. Ry., The Pas, Manitoba, Can.
Purdy, G. A., Supv. B. & B., M. K. & T., Denison, Tex.
Rehmert, D. L., Mast. Carp., P. C. C. & St. L., Bradford, Ohio.
Reynolds, J. W., Carp. For., O. S. L., Pocatello, Idaho.
Roberts, A. C., Supv. B. & B., Mo. Pac., Monroe, La.
Sayles, H. H., For. B. & B., S. L. & S. F., Cape Girardeau, Mo.
Shobert, Fred, For. B. & B., Sou. Pac., Bakersfield, Cal.
Soothill, F. H. Bldg. Supt., Ill. Cent., Chicago, Ill.
Strate, T. H., Val. Engr., C. M. & St. P., Chicago, Ill.
Sturdevant, A. H., Mast. Carp., C. R. I. & P., El Reno, Okla.
Sughrue, T. G., Supv. B. & B., B. & M., Nashua, N. H.
Tamplin, J. F. Supv. B. & B., C. of Ga., Macon, Ga.
Walker, Fred, For. B. & B., O. S. L., Wellsville, Utah.
Webster, E. R., Asst. Engr., C. M. & St. P., Marion, Iowa.
Welch, W. F., Asst. Br. For., B. & A., Pittsfield, Mass.
Whitlock, L. M., Asst. For. B. & B., Mo. Pac., McGehee, Ark.

The secretary was authorized to cast a ballot electing the 48 applicants to membership.

REPORT OF THE EXECUTIVE COMMITTEE

One meeting of the executive committee was held during the year.

Congress Hotel, Chicago, March 20, 1918.

The meeting was called to order by the president, S. C. Tanner, with the following executive members present: S. C. Tanner, Lee Jutton, C. R. Knowles, Arthur Ridgway, F. E. Weise, J. P. Wood, W.

F. Strouse, J. S. Robinson, J. H. Johnston and C. A. Lichty. Past presidents in attendance were, A. S. Markley, J. H. Markley, J. N. Penwell, A. Montzheimer, L. D. Hadwen, and C. A. Lichty. Other members present were, R. C. Sattley, W. O. Eggleston, J. D. Black, E. T. Howson, J. Dupree, and B. R. Kulp.

The question was brought up as to the advisability of changing the location of the 1918 convention from New York City to some more central point as it was thought by many that it would not be wise under the existing conditions to hold the meeting in New York City. A number of other cities were considered, among the most prominent being Cincinnati, Chicago and St. Louis. After considerable discussion it was decided to hold the convention in Chicago.

The president appointed Messrs. Knowles, Jutton and Weise a committee on arrangements for the next convention.

No further business appearing the meeting was adjourned.

C. A. Lichty,
Secretary.

The President:—We will now have reports from the other standing committees.

REPORT OF COMMITTEE ON RELIEF

Joliet, Ill., Oct. 14, 1918.

To the Members of the American Railway Bridge and Building Association:

The committee on relief has received no requests for assistance during the year. It is indeed a pleasure to make a report of this character and indicates that our members are in very satisfactory circumstances.

Respectfully submitted,
Arthur Montzheimer,
Committee.

REPORT OF THE OBITUARY COMMITTEE

Salem, Mass., Oct. 12, 1918.

To the Members of the Association:

God in his divine wisdom, has seen fit to remove from our active membership and transfer to that greater membership the following: T. H. Bridges, McGehee, Ark., W. S. Danes, Peru, Ind., C. W. Lamb, Pine Bluff, Ark., W. R. Lanning, St. Maries, Idaho, E. S. Meloy, Chicago, J. C. Nelson, Norfolk, Va., S. J. Powell, Ogden, Utah, C. A. Redinger, Selma, N. C., A. P. Rice, Columbia, S. C., R. E. Todd, Madison, Wis., and D. C. Zook, Ft. Wayne, Ind.

Be it resolved that we hereby express our sense of bereavement and loss, that a copy of this resolution be spread upon our records and also sent to the families of our departed brothers with assurance of our grief and sympathy.

Respectfully submitted,
B. F. Pickering,
Committee.

The report of the committee was adopted.

Letters and telegrams were read from a considerable number of members who were unable to be present, among them being past presidents, Pickering, Andrews, Rear, Killam and Smith.

The President:—This completes the preliminary business. We will now take up one of the subjects for report and discussion before the noon hour. We will first take up the report on

Repairing and Strengthening Old Masonry. As the chairman, Mr. Strouse, is not present we will ask the secretary to read the report. (See report and discussion.)

A representative from the Liberty Loan committee gave a "four minute talk" on the Fourth Liberty loan after which the meeting was adjourned until 2 p. m.

AFTERNOON SESSION

Tuesday, October 15, 1918.

The meeting was called to order by the president at 2:15 p. m. The discussion on the report of the committee on Repairing and Strengthening Old Masonry was continued for a short time.

The president then called on E. T. Howson to introduce C. A. Morse, who read a paper entitled, "What is Essential Work?"

E. T. Howson:—When the railroads passed under Government control on January 1st all of the problems incident to their operations were transferred into the hands of the Government. Bridge and building men automatically came under the jurisdiction of the Government. The railway administration has had to build up a new organization. One of the most important branches is naturally that for the maintenance of existing properties.

About two months ago a man from Chicago, known personally to a considerable number of men in this Association, and known by reputation to all of them, was appointed Assistant Director of Maintenance in charge of maintenance work on all the railroads under Government control. Mr. Morse, who was chosen for that work and who is going to speak to us now on Essential Work, was at that time chief engineer of the Rock Island System and formerly of the Sante Fe System. He has spent his entire active life in railroad work. Mr. Morse is particularly fitted for this position in the federal Maintenance of Way organization because he has so long been an active student of maintenance problems. He is now president of the American Railway Engineering Association.

When Mr. Morse was asked to speak before this Association the suggestion was made that one of the most acute problems confronting bridge and building men is to determine what is essential work, and Mr. Morse has consented to speak for us on that topic.

Mr. Morse:—I have written out what I have to say, know-

ing that I think better sitting down than I do standing up, but before reading what I have prepared I want to give you a little idea of a few things I have picked up in Washington that possibly have some bearing on what I said in the paper.

We all know about the shortage of labor. The shortage of material is greater even than I realized until I went there and got into the game. On rail, for instance, we are going to be in the neighborhood of half a million tons short for 1918 and there are many railroads that didn't order, being afraid of the price which ranges from $30 to $35 and up to $40. For 1919 there is every prospect of our being a million tons short, or of our getting only about two-thirds of the rail next year that we require.

On ties, they figure that the requirements this year were 126 million. The Purchasing committee which handles that say that the best we can do is to get 70 per cent of this number so that we will also be very short of ties.

I don't know just where we stand on material for bridges and buildings but I have been connected with the War Department in connection with the Division of Construction since I have been in Washington and since I have found out what they are doing I am wondering how we get any material. They have an organization at the present time in which they have 323 construction quartermasters, practically engineers. The head of the division told me that when they completed these 323 projects they would have spent a billion dollars on buildings and construction in connection with them.

In addition to this the ship-building operations are requiring an immense amount of work in housing. I was in Newport News the other day and saw a group of buildings they are putting up to take care of their employes. They are building similar groups of buildings all over the country where they are doing shipbuilding.

The President:—Mr. Morse has come from Washington to read this paper to us. I will be glad to entertain a motion that we show our appreciation by giving him a rising vote of thanks.

A rising vote of thanks was then tendered to Mr. Morse.

The President:—We were to have some remarks by Dr. von Schrenk on the Material Problem on Thursday but as he will not be able to be with us on that day we will ask him to discuss this subject now.

REMARKS BY H. VON SCHRENK

H. von Schrenk:—I have failed to prepare a formal written report, but I will be very glad to say a few words about the material situation. All I can possibly say at this time is to echo in very strong words the general remarks which Mr. Morse has just made in regard to the economical use of material.

I know that for many years all of us have wanted the best and many have been the requisitions for the highest classes of materials when others would have been sufficient. The time is upon us now when we have little choice. We are confronted with the situation that lumber, steel and other materials simply are not available.

The bridge man is facing the problem of maintaining structures without materials and labor—in other words he must depend on his wits. I want to speak briefly about the practical question, "How can we best use our wits in meeting the present situation?"

Last year we maintained a rather optimistic viewpoint in regard to the materials necessary in the construction of bridges, but with the demand from the various departments of war, the demands on the part of the large shipbuilding organizations, the poor railroad man is left with practically no material. Yellow pine timber is practically unknown. Douglas fir, of which we used to hear a good deal, cannot be counted on with any degree of regularity. Still we can't run trains on thin air.

Here is the first suggestion: We can repair those parts of a bridge that are in halfway condition so that they can still serve. Last year I suggested the use of small boxes with rock salt immediately under the caps of pile bridges. There are many pile bridges today which we would renew under ordinary circumstances—that is, the piles have probably decayed far enough to remove. Up to the present time we cannot get the piles or the preservatives to treat them. Many of these piles which under ordinary circumstances we would remove, we ought not to remove now if we can in any way secure a year or two additional service from them. I have yet to find any scheme which does the work for so low a cost as those boxes under the caps filled with rock salt, because they are self-feeding. They can do very little harm and may do a great deal of good.

The last time that I looked at spans built in Southern Louisiana five years ago they looked like alabaster; I couldn't drive a knife in them and they have every appearance of lasting two or

three times as long. When it comes to stringers and caps, many a stringer is defective in certain spots. This is a time for us all to consider board planing very seriously—even stringers, if they have to be re-sawed for the purpose of developing the use of such pieces as are good in the form of laminated construction. We did that a few years ago. Think how many pieces can be combined in one and made to serve in a manner fully as serviceable as if one had used a new stick of wood.

To use untreated material may seem like taking a step backward but that is absolutely essential today. We have two preservatives, creosote oil and zinc chloride. A large percentage of creosote oil comes from Europe. We have available less than approximately fifty million gallons of creosote oil. This must supply the army, navy and shipbuilding board and the railroads. The War Industries board has gotten up a very workable scheme of relative necessities for these materials. Of course the railroads generally come last in this list.

Creosote oil will be available to some extent. We have just been advised that they are going to distribute a supply of oil from Washington for such railroad jobs as may be proven necessary. We have to build our structures without that oil wherever we can. For instance for stringers, guard rails, etc., use as much good heart material as is possible so as to avoid the necessity for treatment but on the other hand where it is essential that you should have some oil you should not have any hesitation in asking for it with a reasonable expectation of getting it.

Zinc chloride, which we hear so much of as taking the place of oil, is not available either. In the manufacture of zinc chloride we have to have sulphuric acid, an essential in the manufacture of munitions and an important chemical needed by the army abroad, so no faith should be pinned on the supply of zinc chloride.

At a meeting held to discuss the use of preservatives for wood we all came to the conclusion that it is necessary at this time to close our eyes to many of the high standards we would recommend in ordinary times, and that we should now favor the use of methods and materials if they will serve even for a comparatively short period.

A further point which I believe should be brought out at this time is this: We ought to use every bit of material that can be obtained as close at home as possible. We ought to avoid to the very utmost the necessity of shipping material any greater distances than

possible. We have been accustomed to using white oak and white pine in the past, considering them essential and the only kinds of wood we could use. The United States is blessed with a great many classes of timber, a number of which we didn't think were fit for anything. A few years ago we thought that a stick of beechwood placed in a station platform would be a half mile away by the time you were once around the station. That is practically true but let me say this to you—"necessity is the mother of invention" and we are confronted at the present time with a condition of not what we would like to do but what we have to do. It is amazing, if one will open his eyes, to find the species of wood immediately available which one can well afford to take a chance on today.

Track men have become aware of this condition more quickly than bridge men. For instance, we are using sycamore ties that we rejected 12 months ago. Our principal endeavor should now be to ascertain the materials which are available under our local conditions.

In that connection I am going to suggest that some one of your committees investigate and tabulate information as to the relative stresses which it would be safe to use with the various hardwoods that are available. You ought to have information available in your Association which would tell at a glance what factors of safety it would be possible to attain from different woods which are native to you. Take red oak, for instance, which we have considered unfit for use because of short life. Its use would remove the necessity for many sticks of beech, white oak and other timbers. It seems to me that this information should be spread broadcast.

Another point that I have noticed recently in making inspections which we want to pay increased attention to is the question of fire. As our bridges grow older the danger from grass fires at their ends increases and bridges that we considered fire safe a few years ago are not now so considered.

Salt boxes such as I spoke of will be of much advantage in putting out sparks. By their use a great many piles could be saved which at the present time are rapidly approaching decay. Menacing conditions of this kind can very frequently be remedied by covering the timbers with small pieces of metal or by the application of temporary fire protective paints.

The upshot of this rather rambling discussion is that we will have to broaden our viewpoint as to the fitness of the materials

which we have, forget for the time being that we cannot do things unless we have the best, forget also for the time being that we have to use only specific classes of material and do the best we can with what we have with the anticipation that we are not going to get any more. Above all we must use our wits in making what little we can get give us the very utmost length of service.

The President:—Dr. von Schrenk's discussion deals mostly with the different woods we use. I believe Mr. Howson can say something to us on the metal situation.

Mr. Howson:—I have nothing of my own to offer but have some correspondence that came to me for presentation. We had hoped to have Mr. Parker or Mr. Powell of the Priorities division of the War Industries Board here to discuss the metal situation. They found that they could not be here so Mr. Powell gave me some data which he thought might be of value to our members.

(As he was unable to be present at the convention T. C. Powell, a member of the Priorities Committee of the War Industries Board sent a written communication describing the work of this organization in conserving the steel output of the country for the most essential needs. Abstracts from Mr. Powell's letter and from circulars of the War Industries Board will be found among the reports in this issue.

The President:—We have a letter on the same subject, the conservation of metal, written by George W. Andrews. The Secretary will read the letter.

(See letter elsewhere.)

C. R. Knowles (chairman) was called upon to read the report on Water Supply, (a) Sources of Supply, (b) Wooden Tanks. (See reports and discussion.)

The remainder of the afternoon was consumed in the discussion on wooden tanks. The meeting adjourned at 5:30 to convene at 9:30 a. m. Wednesday.

MORNING SESSION

Wednesday, Oct. 16, 1918.

The meeting was called to order by President S. C. Tanner at 10:00 o'clock.

The President:—The first paper to be presented this morning will be "Carrying Bridges Over" by C. F. Loweth, chief engineer of the Chicago Milwaukee and St. Paul Railway. Mr. Loweth found it necessary to leave for Seattle yesterday morning with the Fed-

eral manager and wanted me to express his regrets at his not being able to be present. He has asked Mr. Stevens to read his paper.

(See paper and discussion.)

The President:—We will not discuss this paper at the present time as we are honored with the presence of Mr. R. H. Aishton, regional director of the Northwestern region, who will tell us how bridge and building men can help win the war.

REMARKS BY MR. R. H. AISHTON

R. H. Aishton:—Mr. President and Members: I am very glad to come over here and meet with you. It is really surprising to me that, with the tremendous epidemic of influenza sweeping over the country, you have as large a representation as you have here today. I can well imagine that many of you would rather be somewhere else.

What can you do to win the war? I don't know (and I say it truthfully) of any class of men unless it be the section men that has so wholly, so thoroughly and so well performed its work as the bridge and building men. There never has been a question about their giving 100 per cent service. It would be folly for me to offer any suggestions to you as to what you could do to help win the war. You are helping. You're doing everything in your power. I know it because I know the railroad men all over this country are doing the same thing. There isn't any question any more when anything arises as to whether we will do it or whether we won't. What goes through every man's mind? Will it help the President; will it help the soldiers in France; will it help win the war? That's the thing that goes through their minds. It isn't a question of personal discomfort, it isn't a question of 44 hr. or 60 hr. work; it isn't a question whether we will ride or not. What is the final analysis that goes through every man's mind? The first thing he thinks is that it must help win the war. How could I offer any specific suggestion as to what you could do to win the war?

This meeting today is responsible for that thought that is in every man's mind. You call it a War Council. What are you counseling about? You are counseling how to meet the conditions that have been brought about by this war. I notice in your program, "Carrying Over Bridges" by Mr. Loweth. What could I tell you about carrying over bridges? You folks know what to do; you know you are short of labor, you know you are short of material; you know there are conditions you never had to meet be-

fore,—and this discussion that you are having here is an indication of what is in your minds. You've got to do everything you can to carry over everything you can carefully, safely and efficiently, and do it with the things you have in hand. In other words, do more than you ever did in your lives with the material you have. That is your problem and you are working it out. We are all working it out.

You know the load these railroads are carrying. Very few people have any real conception of it. We thought we were busy two years ago when the war first started. It can't compare with the transportation being handled today. Take the matter of moving troops. Do you know that during the month of August 400,000 soldiers were delivered at embarkation points and these soldiers were, some of them, moved from the Pacific to the Atlantic Coast?

The Great Northern Railroad handled 19 passenger trains in one day. Every soldier had a bed, a bath and three meals every day through the entire trip. I mention the Great Northern because I happen to know about that. Do you know that for months the transportation lines have not only moved those soldiers but that for months seven soldiers have stepped off the gangplank every minute, day and night? Just think what that means! A steady stream day and night! They have all had to be transported. It takes as much transportation here to transport them as it does on the boats. When you think of that you get some idea of what the transportation lines have to carry.

They couldn't carry it for one minute unless you men that are sitting here and have control of the forces that bring about the conditions that make it safe to move those trains,—did not have in your minds continually the question "What can I do?"

I could go through your entire program in like manner. Here's a report of a committee on Shipping Company Material Economically. Any of the Northwestern employes can tell you that I have burned their hides more than enough on that kind of thing in years gone by. (Applause.)

You can help a great deal. Every car that is moved over these railroads is moved with terrific effort nowadays. You can make up your minds that every car that a bridge man moves with a stick of timber, a handcar or something of that kind is taking the place of a car that ought to be going toward France and Germany with something that is absolutely needed on that battlefront. Get that into your heads. Whenever you see a car moving over a rail-

road unnecessarily you can make up your mind that the fellow shipping that is a slacker. He is working for the Kaiser just as directly as Bernstorff was. I am glad that subject, Shipping Material Economically, was placed on your program and I hope that when you go back you will spread that thought among all the men.

When we think of what is going on over there in France I don't see how anybody can hold back, no matter whether it is money, time, effort or anything else. The least every man can do is to give everything he's got to clean this thing up. You know that the great American and soldier, Gen. John Pershing, stood before the tomb of Lafayette a few months ago and as he laid a wreath on his tomb he said, "Lafayette, we are here." He didn't mean he was there with 100,000 soldiers. He meant that the American nation was there with every cent it had, with every ounce of energy and blood it had. Haven't we got to make good on that? Your boy is there, my boy is there. Wouldn't we be lagging in our duty if we didn't give everything we have? Just think of that a little. That doesn't mean one thing or another,—it means everything. I made as heavy a subscription to the Liberty Loan as I thought I could; I went in debt for it, yet before night I intend going some more. I believe it is the duty of every American citizen to go clean to his neck. I believe he ought to go in debt for it and buy additional Liberty bonds. That's one way you can help.

Mr. Weise:—I think we ought to show our appreciation by giving a rising vote of thanks to Mr. Aishton.

A rising vote of thanks was tendered to Mr. Aishton.

Mr. Aishton:—I appreciate that very much, Mr. President.

The President:—We will now take up the discussion of Mr. Loweth's paper,—Carrying Over Bridges. (See discussion.)

The next subject to be taken up is that of Shipping Company Materials Economically of which Mr. Brantner is chairman. As Mr. Brantner was unable to attend the convention I will ask the secretary to read the report. (See report and discussion.)

The remainder of the morning was taken up in the discussion of the latter report.

The meeting adjourned at noon until 2 o'clock.

AFTERNOON SESSION

The meeting was called to order by the president at 2 p. m. Mr. Tom Lehon stated that he had the pleasure of meeting Major

C. E. Smith (president 1917) a few days previously at Washington where he is in the service of the Government in planning camps and cantonments. Mr. Smith sent greetings to the members in convention.

The President:—We are honored in having with us W. H. Finley, president of the Chicago & North Western, one of our members, who will talk to us for a few minutes.

REMARKS BY MR. W. H. FINLEY

W. H. Finley:—I have always taken a lively interest in this Association, and I only regret that I have not been able to attend all of its conventions. The few that I have attended, I have enjoyed very much indeed. I do not believe that there is another association of this kind in the United States that brings together the practical and the theoretical men as this does. I say that advisedly. I know that a lot of us are theoretical and a lot of us are practical. I do not know of any organization of railroad men that really means more to the railroads than this Association. I still have a very distinct recollection of the time it was first formed and the criticism, the controversy and the discussion as to the necessity for such an organization. The great difficulty and trouble in forming any sort of an organization is the cry that goes up, "We have organizations enough, why create another one?"

I have looked forward with a great deal of pleasure to the reports of this Association's conventions because I knew that everything that was published in your proceedings was the result of an intimate knowledge of the subjects that you reported upon. I do not believe that, in all of the various organizations connected with railroads, any association has done more or given more toward the practical advancement of railroading than this association. (Applause.)

I also know that the bridge and building men of the railroads have been a quiet, uncomplaining set. They have met their problems on all occasions and have carried them out in storm and stress; they have worked uncomplainingly in all kinds of inclement weather; they never asked any odds and they carried out the tasks that were set before them. I believe there is no set of workmen, with probably one exception, on the railroads of the United States today that has received less recognition for the services they have rendered the railroads than the bridge and building forces.

I will always hold in grateful remembrance my early association with the superintendents of bridges and buildings of the only two roads that I have ever worked for. I have been out with them on all sorts of trips and on all occasions. We never asked any odds of each other. We always met the issue. Today when I look back in retrospection over somewhat more than a quarter of a century of engineering and railroad experience, I always hold in warm remembrance my association with the bridge and building department employes of the railroads that I have been connected with. As I said before, they have been an uncomplaining lot, they have done their work, they have asked no odds and I hope that they will now in the immediate future get their reward.

The conditions confronting the bridge man in an emergency can only be compared in a modified degree with what our soldiers, our bridge builders, are going through over in Europe today. I have followed this, as all of you have, with a great deal of interest as far as bridge building was concerned. One of the first things in this war that struck me with a great deal of force was the description written by a newspaper writer of the entry of the German army into Belgium. He described the German general riding over into Belgium and asking for the surrender of the forts at Liege. Being refused he rode back, and the bridge was immediately blown up by the Belgians.

The German pioneers were the bridge builders and engineers who were sent forward to replace that bridge. Think of it for a moment! They were not excited by the question of war or combat. They were simply workmen trying to build a temporary bridge across the river while the Belgians were taking shots at them. That requires a higher degree of courage in my opinion than it does to go over the top in the front trench when you have all that inspiration of combat and fight in you. The same thing was done by the Americans when they bridged the Marne after the Germans had succeeded in crossing it and were driven back. They bridged the Marne under the fire of the Germans. They bridged it standing waist high—shoulder high—in water, without any possible opportunity to do anything but the work they were doing. They were not fighting. If you can stop for a moment and visualize that condition on the Marne, of those engineers being there with one purpose, to put a bridge across so that the American forces could cross. They did it although the

German sharpshooters and machine guns were sweeping the stream from one side to the other. We are giving them every credit.

When I was quite a young man I was living within probably two or three blocks of where the Baltimore & Ohio line from Baltimore to Philadelphia crosses the Brandywine river. Being a young man and just starting in on my life's work I paid more attention probably to the construction of that bridge and it made a greater impression than later work has made upon my mind. The track was about 115 ft. above low water mark and the bridge was an ordinary pin-connected deck truss. They put up false work that I think the majority of you would laugh at today.

The timber was mortised and tenoned as if it was going to stay there during the life of the bridge. They were just driving the last pin, working at night, when a freshet came down the river, took out their false work and dropped the bridge into the roaring torrent.

Of course I got over there very quickly the next morning. I was interested, and anxious. When I arrived at the scene of the accident, I saw an individual out on the middle of a foot bridge directing the operations of recovering the wreckage of the bridge. I worked my way out to him and asked him some questions. He looked at me in a sort of pitying way and said: "Say, are you an engineer?" I said yes. I was afraid I wouldn't have time to say it. He said, "Forget it,' (laughter) and he went on, in the words of Bret Harte, in language that was free, forceful and impolite, directing the forces in recovering the bridge.

To give you an idea of how the ordinary layman looks upon some of these things connected with bridge building, I am going to tell you a story. A very eminent engineer of this country, Dr. Waddell of Kansas City, wrote a book about bridges and bridge specifications years ago. He gave it the Latin name of de Pontibus. It contains valuable information as to bridge construction, bridge design and bridge specifications. Some years ago the Northwestern was building a line in Wisconsin and I happened to be out on the work when I received a telegram to go to Sheboygan and find a letter that would be there for me. I went there and found the letter which stated that the bridge over Pennsylvania Avenue, I think, had been closed to traffic. It seriously interfered with access to the Northwestern freight house and station and I was instructed to see the city engineer

and see if we could not arrive at some way of fixing the bridge up so that it could be put in service. When I went around to the city engineer's office the first man I saw in there was an engineer from a competing company. I said to him, " You know what we are here for, let's go down and look at that bridge." He said, "All right." It was a drawbridge with a couple of fixed spans across the Sheboygan river. I was quite surprised to find that he was agreeing with me on almost every point that I raised about the bridge and its condition and I was at a loss to just understand the situation. Of course, the street car company was anxious to run cars across. I induced the street car company to run some of its heavy cars down there and made some fancy tests as to emergency stops, etc. After we got through with it, we made some rough figures as to the maximum stresses in the drawbridge.

I said, " Gentlemen, this bridge is all right. No reason to put it out of service. You need not put those barriers back."

The members of the board of public works who were with us were all German excepting one fellow named Kelley and I had a sneaking suspicion that he was not German. (Laughter.) They said, " That is all right but we will not put that bridge in service unless you give us a written opinion over your signature that that bridge is safe." I said, "I will be glad to do that."

We went back to the city engineer's office and I wrote out an opinion regarding the bridge and its safety for the traffic passing over it, signed it and handed it to the chairman of the board. Kelley said, "Would you like to see the report of our consulting engineers on this bridge?" Well, I was absolutely taken back. It had never entered my mind that they had secured the services of a consulting engineer to investigate the safety of the bridge. I said I would like to see it and he handed it to me.

The first thought that occurred to me as an engineer was, "How am I going to preserve the ethics of the profession? Here, evidently, is a consulting engineer who has condemned this bridge and I have said it is all right. How in the world am I going to square this thing and get an even break and not discredit the profession?"

I started to read his report in which he said that his firm had a great many years of experience in designing, examining and repairing bridges and that they never condemned a bridge unless it was beyond all hope. After a careful examination of the

bridge and an analysis of the stresses he found that, according to the loading of de Pontibus this bridge was over-stressed and he gave the over-stressage, running up to nearly 300 per cent.

Just then a happy idea struck me. I thought I saw a way of saving the ethics of the profession without discrediting my fellow engineer so I turned to the board of public works and I said, "Gentlemen, I think your consulting engineer is all right. This bridge is not strong enough to carry de Pontibus. Do you run de Pontibus over the bridge?" One gentleman said, "No, sir, I never saw von on the streets of Sheboygan."

I said, "The bridge is safe as long as you don't run de Pontibus over it. Are you willing to put up a sign that this bridge is safe for everything but de Pontibus?" They were quite willing to do it and started out to prepare a sign that de Pontibus couldn't run over the bridge. There isn't any doubt that the majority of the people up there today think that de Pontibus is some sort of a steam road roller.

That was the one and only occasion in my life when I was able, by a method of that sort, to maintain the ethics of the profession.

This war and the times we are going through are epochal. Nothing like it has ever happened in the history of the human race. The conditions that we must meet, the questions that we must solve are questions that were never presented before in the history of our race. They are broad, they are far-reaching. In my opinion there is going to be an entire change of conditions and social usages that have existed in the past. It is up to all of us to give these problems the broadest, most careful consideration, to give them all the thought we can.

One thing has distinguished the United States in comparison with any other Government or any other country in the world and that has been its individualism—the fact that we could develop along our own lines. You might differ with me; we might not agree, but you had the right to go along your own lines and I along my lines and reach the solution of the question as we thought it should be reached. That has, in my mind, been the biggest thing that has put the United States today where it is. It is so different, gentlemen, from what has been the custom in Germany. There one pattern was held out to all the people. They lived up and grew up simply to that pattern. They could not go beyond it. They could not deviate from it. You see the result.

Here, in the United States we have counted on individualism, individual effort and individual initiative. It is this that has made the United States what it is today, a country that in this war has made an effort that was not dreamed of by any country or government in the world. We were smiled at and laughed at by even our friends; that this peace-loving nation, this nation of commercialism, of " dollar chasers," as they chose to call us, could never meet this supreme effort if it was put upon us and yet in less than one year and a half our accomplishments have been far beyond any of the military nations of Europe. It is something that is going to stand in history as one of the most remarkable things that ever took place in the history of the human race—the warlike effort that the United States has put forward. We know, and always knew, that we were not a warlike nation. We didn't pride ourselves on our military strength but almost everything that is used in Europe in this war today is an American invention. The machine gun that the German army today is relying upon more than any other arm is an American invention. The only other thing that is overcoming it, the British tank, is an American invention. The flying machines are an American invention. The submarine is an American invention. Yet we are not a warlike nation.

I never realized fully what our individualism meant until I read Dentist Davis' articles on his associations with the Kaiser. He related one incident that to me was very illuminating. It was this: After an exhibition of the Wright flying machines in Germany some years ago the Kaiser turned to Davis and said: " Davis, I envy your country its inventive genius." He did not realize, and probably does not today, that that inventive genius came from the kind of government we have, the kind of government that did not interfere with individuals—that did not set up that the State was everything and the individual nothing.

It is an easy thing to change our ideas, to change our form of government even under military pressure. I hope and trust that every man within hearing of my voice will still believe in, and will still lend his efforts and his best endeavors to preserve the individualism of the American citizen. Thank you. (Applause.)

The President:—I would like to ask the gentlemen to indicate by a rising vote of thanks their appreciation and thanks for Mr. Finley's remarks.

(Audiences rises and applauds.)

The President called on F. E. Weise to read his report on Labor Saving Devices. (See report and discussion.)

REPORT OF THE AUDITING COMMITTEE

Chicago, Oct. 16, 1918.

To the Officers and Members of the American Railway Bridge and Building Association:

We have examined the books and the accounts of the secretary-treasurer and find them to be correct as given in the report.

J. S. Robinson,
R. C. Sattley,
M. Riney,
Committee.

The secretary stated that reports had not been received on the subjects of "Concrete," and "Painting Metal Structures."

(A paper on "Factory-Made Reinforced-Concrete," by Charles Gilman, bearing particularly on this subject, is reprinted elsewhere in this volume.)

H. A. Gerst read the report of the committee on Bridge Floors and Guards. (See report and discussion.)

J. P. Wood read the report on the subject of Small Versus Large Gangs for Maintenance Work. (See report and discussion.)

The committee reports being completed a vote was taken at 3:30 to decide if the remaining business should be completed during this session or carried over until Thursday morning. The vote was unanimous that the work should be completed Wednesday afternoon and the convention brought to a close.

REPORT OF COMMITTEE ON NOMINATIONS

Chicago, Oct. 16, 1918.

The Committee on Nominations recommends the advancement of the present officers and executive members as has been the custom in the past. E. T. Howson has been recommended for election to fill the vacancy on the executive committee caused by the death of D. C. Zook, and the name of C. W. Wright as the sixth member of said committee.

R. H. Reid,
J. P. Canty,
J. B. Sheldon,
Committee.

ELECTION OF OFFICERS

W. M. Camp moved that the rules be suspended and that A. H. King cast the ballot for the convention, electing the officers and executive members recommended in the committee's report. The motion was carried which resulted in the election of the following:

Officers: Lee Jutton, president; F. E. Weise, first vice president; W. F. Strouse, second vice president; C. R. Knowles, third vice president; Arthur Ridgway, fourth vice president; C. A. Lichty, secretary-treasurer. Executive Members: J. S. Robinson, J. P. Wood, A. B. McVay, J. H. Johnston, E. T. Howson and C. W. Wright.

President Tanner:—Before retiring from the office of president, which I have had the honor to hold during the historical year of 1918 I wish to thank each and all of you for your loyal support, and especially the chairmen and the members of the various committees. The fiscal year which is just closing has been a memorable one. We have had many perplexing problems to contend with. There were times when we did not know whether or not we would be permitted to hold a convention and it became necessary to take the matter up with the Railroad Administration, when it was decided that we could continue in the regular way. Then about the time we were preparing to go to the convention the terrible epidemic of influenza was prevalent and this has given us a noticeable setback for attendance. Many of our members had all arrangements made to be here but were finally detained on account of conditions growing out of the epidemic. Nevertheless, we have had a successful meeting and I wish to thank you all for your faithfulness.

Mr. Jutton, will you please come forward? You have been elected president of this association which is the highest honor it can bestow upon any of its members. In presenting this gavel I can assure you that there are no "slackers" in this organization, and I bespeak for you the loyal support of its members that they have given their officers in the past which is a record that any organization can be proud of.

President Jutton:—Mr. Tanner and Fellow Members: I want to say that I am truly grateful for the honor you have accorded me. I realize fully that with this office goes the responsibility of keeping our association in a healthy condition and I will certainly give my best efforts. I must also say that in accomplishing the best ends it will be necessary for me to have the support of all the members and I only ask that I be given the support you have given our presidents in the past. It will be necessary for our committees to work faithfully to keep up the reputation they have established in former years. I thank you, gentlemen.

The other officers were duly installed.

The President:—We will now decide where the next convention will be held. Nominations are in order.

A. H. King nominated New York City, stating that the executive committee had the right to change the location if for any reason it became necessary.

J. Dupree nominated Washington, D. C., but the nomination

was withdrawn after remarks made by President Tanner wherein he stated that the city of Washington was a very poor place to meet as the hotels were very much crowded and likely would be for some time to come.

W. M. Camp nominated Philadelphia, followed by St. Paul, by E. T. Howson; F. C. Baluss placed in nomination Atlanta, R. H. Reid, Cleveland, and L. Jutton, Indianapolis.

The ballot resulted in the selection of Cleveland, the vote being made unanimous.

REPORT OF COMMITTEE ON SUBJECTS

Chicago, Oct. 15, 1918.

To the Chairman and Members:—

The committee on subjects submits the following list, which is to be completed at the March meeting by adding new subjects and inviting various members and others to submit papers, as has been the custom in late years:

Methods and Equipment Used in Renewing Timber Bridges.
Inspection and Repairs of Roofs.
Methods of Bridge Inspection Under Present Conditions.
Economical Use and Storage of Fuel at Railway Pumping Stations.
Painting Metal Railroad Structures.
Tools.
Paper,—Railway Fire Equipment.

Respectfully submitted,
F. E. Weise,
E. T. Howson,
C. E. Smith,
Committee.

The secretary recommended the names of the following members for life membership: Ed Gagnon, retired supervisor of bridges and buildings on the Minneapolis & St. Louis; Amos H. Beard, retired master carpenter, Philadelphia & Reading, and Albert Mountfort, pensioned division foreman of bridges and buildings, Boston & Maine.

The above named members were elected to life membership.

C. R. Knowles made a motion that if the Association had any money to spare it might be invested in Liberty bonds. It was voted to leave this to the discretion of the executive committee.

The Secretary:—I wish to state that in accordance with the instructions which I received at the last convention I wrote to Phelps Johnson, president of the St. Lawrence Bridge Co., at Montreal, conveying to him and his Company the congratulations of the Association upon the successful completion of the great Quebec bridge.

The following communication was received from Mr. Johnson in reply:

C. A. Lichty, Secretary,
My Dear Mr. Lichty:—

I have been absent from Montreal for a week or so and upon my return I find awaiting me your letter conveying to me and my Company the congratulations of the Association upon the successful completion of the Quebec bridge. I am indeed very pleased to have your communication for I appreciate that the congratulations come from a body of men who really know what was involved in the work we have done and who are best qualified to pass judgment upon it.

With best wishes for yourself and the Association.

Yours very truly,
(Signed) Phelps Johnson,
Pres. St. Lawrence Bridge Co., Ltd.

PATTERSON MEMORIAL

W. M. Camp reported on the Patterson Memorial as follows:

The proceedings of the special memorial meeting held at last year's convention were edited and published in a special volume and these were sent to the members and the usual depositories where our proceedings are kept.

A subscription was taken for a memorial block and tablet to be placed on the burial lot. That subscription, together with subsequent contributions which were sent in during the winter, now amounts to $210.75 which is in the hands of the treasurer. A canvass of the art market developed that it would be unwise to carry out the plan at present on account of war conditions. It is my understanding that this matter was to be deferred until conditions are more favorable.

The President:—If there are no objections the committee will be continued until its work can be accomplished under more favorable conditions.

We will now have the report of the committee on resolutions.

REPORT OF THE COMMITTEE ON RESOLUTIONS

Chicago, Oct. 16, 1918.

Resolved:—That the thanks of the Association be extended to the following individuals and corporations:

To the United States Railroad Administration for sanctioning the holding of this meeting:

To Messrs. R. H. Aishton, C. A. Morse, W. H. Finley and C. F. Loweth for their interesting and instructive papers and addresses:

To George F. Porter, for the interesting photographic views, moving pictures and address on the erection of the Quebec bridge:

To C. K. Melton for presenting slides, moving pictures and lecture on Mississippi river flood protection:

To the Pullman Company for extending half rates and to the

various railroads for the transportation of our members and their families to and from the convention:

To the New York Central for transportation to and from the Universal Cement Company's plant at Buffington, Ind.:

To the Universal Portland Cement Company for inviting our members to visit their plant and for the excellent lunch provided:

To the press and technical journals and their representatives in reporting the activities of the convention:

To the officers, chairmen and members of committees, who, under existing trying conditions, gave their time and efforts which resulted in the success of this convention:

Be it further resolved that these resolutions be spread on the minutes and the secretary instructed to forward copies to all parties interested.

Respectfully submitted,
F. E. Schall,
J. P. Wood,
P. J. O'Neill,
Committee.

The President:—This completes the business of the twenty-eighth annual convention and I wish to thank you all for the good attendance and close attention to business. Although the attendance has not been up to the average of recent years this has been on account of conditions resulting from the war and more so on account of the raging epidemic of Spanish influenza in all parts of the country which has kept many from attending who would otherwise have been here. Despite war conditions it appeared a short time ago that we might have a record attendance. The Federal managers of the railroads certainly did all they could to assist our members in getting here.

We will now adjourn to meet in Cleveland the third Tuesday in October, 1919, unless it is deemed wise by the executive committee to change the location of the convention.

C. A. Lichty,
Secretary.

Reported by Master Reporting Co., Chicago.

MEMOIR

JOHN C. NELSON

John C. Nelson, engineer maintenance of way of the Seaboard Air Line, died at Norfolk, Va., on October 6, following an attack of Spanish influenza. He was born at Belton, Texas, on November 3, 1862, and entered railway service with the Richmond & Mecklenburg Railroad, as a rodman on an engineering corps, in July, 1882. From February, 1883, to April of the same year he was a levelman with the Richmond & Danville Railway, from which time until February, 1884, he was resident engineer with the Richmond & Mecklenburg road. From the latter date until March, 1891, he was assistant engineer on the Cincinnati, New Orleans & Texas Pacific and from March, 1891, to May, he was resident engineer on the Louisville Southern. After three months' service with the Cincinnati, New Orleans & Texas Pacific as an assistant engineer he went with the Cleveland, Cincinnati, Chicago & St. Louis as engineer maintenance of way on the Cincinnati division, with headquarters at Springfield, Ohio. In September, 1899, he was appointed division engineer on the eastern division of the New York Central & Hudson River Railroad, with headquarters at New York, where he remained until 1902, when he returned to the Cincinnati, New Orleans & Texas Pacific as roadmaster. In 1907 he was appointed engineer maintenance of way of the Seaboard Air Line, which position he held until the time of his death.

Mr. Nelson was highly esteemed by his associates and his sudden death was a great shock to them. During the eleven years of his connection with the Seaboard Air Line Railway, he had impressed his personality upon his associates in a manner which will long be remembered.

He became a member of the American Railway Bridge and Building Association at Jacksonville, in 1909.

W. R. LANNING

Wm. R. Lanning was born near Ottumwa, Iowa, on June 25, 1869. He received his education in the public schools, leaving at the age of 15 to learn the carpenter trade. His first railroad experience was gained with the old Chicago, Ft. Madison & Des Moines Railroad; in March, 1893, he was employed by the Chicago, Milwaukee & St. Paul Railway as a carpenter. Shortly after this he left to work at his trade elsewhere and also took up contracting and building. In 1907 he again entered the service of the C. M. & St. P. Ry., being located at Pontis, South Dakota, where the construction of the Puget Sound line was under way. In 1907 he was made carpenter foreman and in August, 1908, he was promoted to the position of chief carpenter, which position he held until March, 1915, when he was obliged to take a leave of absence because of ill health. After a few months he again returned to service as chief carpenter at St. Maries, Idaho, in which position he remained until his death on Apr. 8, 1918.

Mr. Lanning was in poor health for the last few years of his life and his trouble was largely aggravated by exposure during washouts in the Bitter Root mountains near Avery, Idaho, during the latter part of 1917. He died at his home in Missoula, Mont., on April 8, 1918, leaving a wife and three sons, Russell, Burdette and Harold, the latter being a sergeant in the United States army. He was connected with the Christian church of Missoula, Mont., and also belonged to the Fraternal Brotherhood.

Mr. Lanning took a very active part in the work required by the railroad during the fires in the Bitter Root mountains in 1910, and fre-

quently referred to this period as being the most important in his railroad career. The following extract from an article published in Everybody's Magazine of December, 1910, indicates the active part which Mr. Lanning took in that event:

"On the day the fire became unmanageable there were no fewer than 1,000 people along the line of the C. M. & P. S. railroad in the 48 miles between Avery, Idaho, and Haugan, Montana. These were mainly railway employees, their wives and children, and refugees from the interior, although there were many tradespeople in the villages. Four work trains were busy on that stretch of track under the direction of C. H. Marshall and W. R. Lanning, superintendent and chief carpenter, respectively, of the Missoula division. A telephone message to Superintendent Marshall from the girl operator at Kyle, a small station, gave the first alarm of the approaching fire. While they were talking the wires went down.

"Marshall and Lanning at once ordered two of the trains to proceed along the line, picking up everybody. 'Don't pass anybody, no matter who it is, and put every living soul aboard, whether they want to go or not,' was the order given to the trainmen and a few American laborers who, the railroad officials knew from past experience, were the only men in the jumble of nationalities upon whom they could depend.

"Before the trains had gone far the fire was in sight. From mountain to mountain the flames leaped, with the speed of a fast train sowing brands upon the slopes to kindle slower, even more deadly fires. With the fire came the gale. Stones of a pound weight, gravel, dust, debris of the forest, were hurled before it, and soon clouds of smoke, fire-tainted, scorching, thicker than ever, completely obscured the sun.

"More than 400 people were herded into the cars east of the St. Paul Pass tunnel by Lanning and carried into the great tube, which is almost two miles long. There they remained in safety, suffering somewhat from smoke. Under the direction of Superintendent Marshall several hundred were taken out by the way of the east to Haugan. In another, and shorter tunnel, 200 people found refuge. They were pulled there on a train by Engineer Roberts, who ran a blazing bridge, over 700 ft. long and 100 ft. high, to put them there. When they reached the tunnel the fuel oil in the tank was frying.

"But that did not take care of the people. Scattered along the line between the great tunnel and Kyle, Idaho, were many whom it seemed impossible to save. The fire was pouring across the track, many bridges were going. 'We'll make a try for it, just the same,' said Lanning.

"An engineer and a fireman volunteered for the perilous venture, likewise a conductor on one of the work trains. With an engine and three cars they set out. It was apparent to all as they proceeded that they would never be able to return to the big tunnel. When the train reached the refugees huddled along the track, many of them had to be lifted in bodily, cutting from their backs rolls of blankets and any other inflammable material. Water in barrels at the ends of the bridges was boiled and evaporated away, the staves burning down to the level of the water as it sank. Fish in the streams were cooked; for days they floated, by thousands. Ties were burned out of the railroad track, the rails were buckled and kinked like wire. Everything was swept clean to the tunnel's mouths.

"After 48 hours in this hot dungeon, chief carpenter Lanning walked out, to find 19 of his bridges burned in 48 miles of track. He went to work to replace them. With 500 men, working night and day, he labored. In 11½ days he rebuilt 16 bridges, ranging from 360 to 775 ft. in length, and from 16 to 120 ft. high, every one of them standard permanent bridges. It was one of the most stupendous achievements in the history of railroading.

"Besides that, Lanning alone, has to his credit 500 human lives. He hasn't much to say about it; only this: 'An American owes that to his country and his kind.'"

EDWARD S. MELOY

Edward S. Meloy, an assistant engineer in the engineering department of the Chicago, Milwaukee & St. Paul Railway was born in Waterbury, Connecticut, on March 9, 1860 and died in Chicago, Illinois, on July 8, 1918. He began his railroad career as a rodman with the New York and New England Railroad in 1878, following which he was resident engineer with the N. Y. C. & St. L. Ry., locating engineer with the M. & O. R. R., and in charge of track laying with the B. H. T. & W. R. R., and the C. & N. W. Ry. In the autumn of 1886 he entered the service of the C. M. & St. P., and was located successively at Chillicothe, Mo., Marion, Ia., Milwaukee, Wis., Tomah, Wis., and Chicago, Ill. At the time of his death he was assistant engineer in charge of bridge inspection and bridge erection. In his efficient, loyal and conscientious service of over 30 years he made many friends. The funeral service was conducted by Bishop William O. Shepard of the Methodist Episcopal Church, a warm personal friend of more than 20 years' acquaintance, from whose remarks the following brief abstract is taken:

"Mr. Meloy was a substantial man to lean upon. He was steadfast, loyal, certain and true. You can easily tell that by the fact that he continued in one employment, rising to greater and still greater honor and responsibility, for a third of a century. During all that time, he was constant in doing his part, in his place, with increasing efficiency, —doing his part of the necessary work of the world.

"If I were to try to put into a single word what I thought was characteristic of Mr. Meloy, I think that I should have to use the word 'faithfulness,' or the word 'loyal,' or the word 'constancy.' And I should not be quite satisfied with any one of these words, but should wish to bring in some suggestion of his gentleness, and gentlemanliness. He was one upon whom you could depend. He would not make a rash promise at all. But he would make a promise to a friend, and keep it."

D. C. ZOOK

Dennis Coder Zook was born March 14, 1852, in Wyandot County, Ohio, son of Daniel and Nancy (Steele) Zook, both natives of Pennsylvania. He received his early education in the common schools in the vicinity where he was born. After a thorough knowledge of carpentry Mr. Zook entered the employ of the Pennsylvania railroad on June 1, 1873. Ten years later he was made foreman of a carpenter gang at Valparaiso, Indiana, which position he retained until 1897 when he received the title of master carpenter in which capacity he served with headquarters at Fort Wayne, Ind., until his death.

Mr. Zook had been in failing health for several years but his condition was not considered serious until a few days before his death, when he was removed to the Deaconess hospital at Indianapolis at which place he slept away apparently without pain on the morning of March 28, 1918, from heart disease.

In his long continuous connection with the Pennsylvania railroad Mr. Zook came to be known and respected as one of the company's most venerable and valued employes. His death ends a long career of efficient and devoted service and represents a deep sorrow to his hosts of acquaintances in railroad and lodge circles in Fort Wayne. He was an ardent member of the Methodist Episcopal church and an esteemed member of the Masonic fraternity. He joined the American Railway Bridge and

D. C. Zook

Building Association in 1902, and attended most of the conventions since that time, always being accompanied by his wife.

Mr. Zook is survived by a wife and five children—two daughters and three sons. One daughter,—Edith,—is the wife of F. A. Taylor, master carpenter of the Baltimore & Ohio, at Cumberland, Md.

Interment was at Lindenwood cemetery at Fort Wayne.

ALVA PEYTON RICE

(By Captain Charles S. Dwight)

Mr. Rice was a native of Robeson County, North Carolina. He was born on July 7, 1855. His father was a substantial and respected farmer and a faithful soldier during the entire war in the Army of Northern Virginia under General Robert E. Lee.

When only a stalwart youth A. P. Rice left home with only his father's blessing to seek his fortune in the great world. In that stirring time of rebuilding the war-ruined south, he at once found place with companies of bridgebuilders, whose work was exactly suited to his remarkable strength and untiring energy. In this service he spent many years most successfully, earning high reputation in the construction and erection of many important bridges and trestles on the great railways of the south.

But his best work was yet to be done. In 1903 William G. Childs, president of the Columbia, Newberry & Laurens R. R., appointed A. P. Rice roadmaster. This railroad had been rapidly and cheaply built. It was well located, but it was wholly devoid of ballast and had an excessive amount of wooden trestle which was getting beyond even radical repair. The rapidly increasing tonnage of engines and traffic was proving too heavy for the light rail and "dirt" roadbed. The president wisely decided to ballast the roadbed, and replace wooden trestles with earth,

steel and masonry. Here was the problem of the engineer and the roadmaster, especially the latter. At once Rice's qualities came into play. He was peculiarly gifted in discerning what was needed and where it was most needed, how to get what was needed by convincing the president of the need, and then in using his material most quickly and advantageously; and he had learned, too, that the best material is the cheapest, and would use no other except in emergency.

Beginning with the worst places and working systematically, his labors soon began to tell. Long before his death on December 24, 1917, "slow orders" which had been the bane of the road had become only a memory, entire winters passing without the issuance of one. Rice's ingenuity and resourcefulness were displayed in the building and maintenance of so many temporary structures under which permanent construction was effected; there was never a mishap or failure; in replacing a bridge 2,217 feet long there was not an accident nor a delayed train.

Alva P. Rice was a strong man intellectually and morally. With the

A. P. Rice

most limited opportunity for early education he became a well informed, broadminded man and a useful citizen, attaining these by hard study and extensive reading.

The deep sense of loss that is felt by the president, the engineer and the entire staff of the Columbia, Newberry and Laurens Railroad, and more poignantly, of course, by his own family, is the true measure of his real worth and character.

Mr. Rice married, Dec. 12, 1888, Miss Nannie Elizabeth Maund, of Columbia, Alabama, who, with a grown son and daughter, survives him.

Mr. Rice was a Mason, an Oddfellow, a Knight of Pythias, and a member of the American Railway Bridge and Building Association and of the Roadmasters' Association.

C. A. REDINGER

Charles Austin Redinger was born near Ridgeway, Mo., May 25, 1886, and died at a sanitarium near Boerne, Texas, March 15, 1918. He attended high school in his native town, completing the four year course in three years at the age of 18. He soon afterward went to St. Louis where he secured employment with the circuit court as stenographer and

copyist. Here he began the study of civil engineering, working during the day and studying at night. He took private lessons from Professor Brown at Washington University as well as a course in one of the correspondence schools. Later he secured a position with the Southern Railway and continued in the service of that road until the time of his death. He held various positions in the engineering department and

C. A. Redinger

made good in his work until he was compelled to seek rest at the Boerne sanitarium, where he went in November, 1917, thinking the warmer climate during the winter might be a benefit to his health.

Mr. Redinger is survived by his father and mother, three sisters and two brothers. He was a consistent member of the Methodist church and the funeral was conducted from his home church at Ridgeway.

He joined the American Railway Bridge and Building Association in 1912 at the Baltimore convention.

W. S. DANES

W. S. Danes was born at Belleville, Mich., July 7, 1853, and died February 22, 1918, from apoplexy at the Frances E. Willard hospital, Chicago.

Mr. Danes entered the service of the Wabash railroad in 1880 and the diligence that marked his entire railroad career resulted in promotions successively to bridge foreman, master carpenter, superintendent of bridges and buildings and engineer maintenance of way.

He was widely known and highly respected as a citizen in Peru, Ind., where he had made his home for many years. He is survived by his widow, Alice Cain Danes.

Mr. Danes was a Knight Templar, 32nd degree mason, a shriner, and

W. S. Danes

a member of the American Railway Bridge and Building Association, having joined the latter in 1892, and was its president, 1901-'02.

S. J. POWELL

(By A. H. King)

S. J. Powell was born July 11, 1851, at Winchester, Franklin Co., O., and died as the result of a surgical operation in April, 1918.

Mr. Powell began service with the bridge and building department of the Union Pacific in 1879 and was later transferred to the Oregon Short Line where he occupied the position of division foreman at the time of his death. He was of an exceptionally genial disposition and made friends wherever he went. He learned his trade thoroughly and was rated as a first class foreman. He leaves a widow, three grown daughters and a son in military service in France. Interment was made from the Catholic church at Ogden, Utah.

Mr. Powell joined the Association in 1911.

REPAIRING AND STRENGTHENING OLD MASONRY

COMMITTEE REPORT

Last year's report consisted of a compilation of the replies to the questionnaire prepared by Mr. Gauthier before his departure for oversea duty. Owing to the great stress under which railroad men engaged in construction and maintenance work are now laboring because of conditions brought about by the world war, it was not thought advisable to follow the same plan this year.

As all the members of the committee are now, or have been more or less intimately associated with work embraced by the above subject, they were requested to furnish data from their own experience which could be embodied into a report. Before proceeding, however, with the report proper, prepared from the data submitted, I have deemed it advisable to refer, in more or less detail, to the report submitted by the masonry committee of the American Railway Engineering Association in 1911, in which are given the more common causes of masonry failure, or conditions, the results of which bring about the necessity of repairing and strengthening masonry. While the above report deals particularly with concrete construction, it is applicable in its essential features, to all classes of masonry, and treats this particular phase of the subject in a much broader manner than was done last year.

The following causes are mentioned:

(1) Faulty design.

(a) Where masonry is placed on grillages above the water line, or where the water level is lowered after construction, causing the grillages to rot and allowing the masonry to settle.

(b) Where the grillage rests on piles and where the designer used too high a stress for timbers in compression.

(c) Where the wing walls of U-abutments were built too light.

(d) Where the designer or engineer used too high a unit pressure on the earth, or on piles upon which it was to rest.

(e) Settlement of the body of a structure causing cracks to appear where the wings leave the main portion of the structure or, in the case of arches, at points back of the parapets.

(f) Lack of proper drainage.

(2) Poor material or poor workmanship.

(3) Temperature cracks.

(4) Disintegration of the masonry.

(a) On account of the freezing and thawing of exposed surfaces of masonry, particularly where water drips through an arch ring, or where the masonry near the ground is exposed to alternate freezing and thawing.

(b) On account of masonry being exposed to salt water, alkalies, acids or heat.

(5) Improper filling.

(6) Scouring away of the material underneath the masonry.

(a) On account of unusual freshets.

(b) On account of driftwood, wagon bridges, etc., lodging against the masonry.

(c) On account of ice gorges.

(d) On account of the size of the opening being too small, which causes the water to rise during a freshet, and which increases the velocity of the stream sufficient to scour away the material underneath the masonry.

(7) Material sliding and carrying the masonry with it.

Faulty Design

If settlement resulting from faulty design, cases (a), (b) and (d), is not uniform in large structures they will probably crack unless reinforced so as to prevent settlement cracks. An ordinary single track abutment up to about 20 or 25 ft. in height would probably settle without cracking. If the abutment were built in sections, the different sections would be divided in a vertical plane and prevent unsightly cracks.

In the case of arches (f) under high fills and supported on ordinary soils it is difficult to prevent cracking of the abutments and ring unless reinforcement is used, on account of the pressure on the foundation in the center of the arch being very great when compared with the pressure at the ends of the wing walls. The monolithic character of an arch of standard design is not strong enough to distribute the load uniformly over the foundation and when a slight settlement occurs in the center, it is liable to cause cracks that are unsightly but not necessarily dangerous.

Poor Material or Poor Workmanship

Failures due to poor material or workmanship can be avoided with proper care. Portland cement, as now placed upon the market, is very reliable and few failures can be traced to this important ingredient. The use of dirty sand or a poor grade of stone generally rests with the engineer. Workmanship can not be controlled as readily where inefficient or unskilled labor is employed. However, a competent inspector can generally get satisfactory results.

Temperature Cracks

Temperature cracks will always occur in long walls, although some railroads report abutments built of plain concrete in lengths of 60 to 100 ft., without cracking and when reinforced in lengths of 150 ft. The engineering profession is not now so widely divided on the effect of temperature changes in ordinary monolithic structures and expansion joints are generally introduced at intervals of from 40 to 50 ft. As masonry expands and contracts more than the adjacent material, it follows that it must be built strong enough to overcome the friction or fail.

Disintegration of the Masonry

Disintegration case (a) can be prevented in the case of arches and to a great extent in abutments and retaining walls by proper water proofing which will prevent dripping or seepage and the consequent results of freezing and thawing on the surfaces. Very little protection to exposed surfaces, however, can be provided beyond the use of the most durable material available, placed in a thoroughly workmanlike manner.

Improper Filling

A properly designed monolithic structure will resist failure, due to careless or improper filling, better than a structure built in sections. This is another instance where proper inspection and supervision can be exercised to good advantage.

Scouring of the Material Underneath the Masonry

In designing structures over streams the size of openings should be such as to take care of the maximum amount of water that is likely to come to the opening. It frequently happens, however, that the amount of water is underestimated or that the opening is blocked with driftwood, ice gorges or other material, which either induces scour in the bed of the stream or raises the high water mark or both. Should the scour extend below the foundations the structure is liable to settle forward or bodily downward. A monolithic structure will resist failure bet-

ter than one built in sections, but cracks are liable to occur in either event. Complete failure in many instances can be prevented by relieving the pressure at the back or placing struts across the opening.

Material Sliding and Carrying the Masonry With It

A properly designed monolithic structure will resist failure due to material sliding and carrying masonry with it better than a structure built in sections. However, we have many cases of record where the need of repairing and strengthening old masonry was not brought about by any of the causes above enumerated. Many old structures would have lasted indefinitely had not the weight of rolling stock been increased beyond that for which they were originally designed.

The stresses due to increased loading have been multiplied many times in the case of structures built 50 or 60 years ago, and those which have not failed or shown signs of distress were either designed for much heavier loadings or were exceedingly well built. For this reason one should not be too hasty in concluding that failure was due to faulty design. A case bearing on this point, will be treated later.

We should not lose sight of the fact that engineers today have much more reliable and accurate data upon which to design the majority of modern railroad structures than had the engineers of the early days of railroad construction. Many recent failures of masonry built of limestone, for example, would not have occurred under the loading for which the structures were designed. This stone, except the better grades, will not stand up under present traffic. The same might be said of concrete unless properly reinforced and built of high grade materials of proper proportions.

Attention has already been called in the early part of this paper, to the fact that many masonry failures are not due to any of the seven causes mentioned but to overloading the structures. Very positive proof of this assertion can be found upon looking into the history of two of the oldest masonry structures on the Baltimore & Ohio Railroad. Incidentally these bridges are among the oldest, if not the oldest, railroad bridges of their class, not only in the United States, but in the world.

Gwynns Falls Viaduct, Showing South Portal of Arch, Original Construction, B. & O. R. R.

The first and oldest of these bridges is a double track stone viaduct having a total length of 297 ft., in the center of which is an 80 ft. semicircular arch spanning Gwynns Falls near Mt. Clare Junction, Baltimore, Md. It was erected by James Lloyd in 1829 of native granite cut to a true surface and laid in lime mortar. The retaining or wing walls forming the approaches to the arch are reinforced at intervals of 25 ft. by massive battered pilasters extending the full height of the structure, the top of which is 65.5 ft. above the bed of the stream.

Instead of filling the space above the arch and between the parapets as is the present day custom, longitudinal brick walls 12 in. thick and spaced 3 ft. center to center, with cross walls of similar construction located at 5 ft. intervals were constructed on the haunches and over the arch, upon which were placed granite slabs 12 in. thick, to form the subgrade of the roadbed. The parapets or side walls originally extended to a height of about 4 ft. above the track grade.

As new ballast was placed from time to time, the track grade was gradually raised, until at the present time, it approximates the grade of the top of the parapets. This and the increased weight of rolling stock, produced a greater thrust against the parapets than they were designed to stand. It was therefore necessary to take down and rebuild the wall on one side about two years ago and the other is now being treated in a similar manner. To prevent a recurrence of the trouble experienced in the past, these walls are being reset with concrete backing extending well back under the tracks to take the thrust from the walls proper. In resetting the face stones special care is taken to place them in their former positions to preserve as far as possible the original character of the structure. Outside of this work, and sealing with concrete the

General View Gwynns Falls Viaduct, Showing Pilasters and Panels in Side Walls

foundation under the west abutment of the arch, which had been exposed by erosion, no repairs have heretofore been made and the balance of the structure, after about 89 years of service, is in an excellent state of preservation. Had the original grade been maintained, it is probable that no repairs to the superstructure would have been necessary for many years to come.

The second bridge above referred to, while not quite as old, is still of greater historical value. It is known as the Thomas Viaduct, and crosses the Patapsco river at Relay, Md., about 8 miles west of Baltimore. It is a double track bridge consisting of a series of eight semicircular arches, each having a span of 58 ft. at the spring line, the

View Showing the Poor Character of Foundation Masonry Under Gwynns Falls Arch as Disclosed When Work of Sealing Foundations Was Done

Thomas Viaduct, B. & O. R. R., Relay, Md.
Built 1833 to 1835

total length of the structure being 612 ft. with a height of 59 ft. above the bed of the river. It was built of native granite in 1833 to 1835.

The subgrade or roadbed of this structure was also formed by the

construction of brick longitudinal and cross walls supporting granite slabs as described for the viaduct over Gwynns Falls. The feature of special interest in this structure, however, is the fact that it is located upon a four degree curve. With the exception of resetting the parapet walls several years ago, which failed for the same reason given in the case of the Gwynns Falls viaduct, no repairs have been necessary, and the balance of the structure is apparently in as good condition as when first built, after about 83 years of service.

From the accompanying photographs and text it will be noted the general designs of the two structures were very much the same, except that in the Gwynns Falls viaduct the exposed surfaces of all masonry were dressed to a fairly smooth surface, with panels introduced in the large blank spaces between the pilasters and above the arch ring, while all exposed surfaces of the Thomas viaduct except the inner surfaces of the ring stones were left with rock face finish.

To the writer the most remarkable feature surrounding these old bridges, is the fact, that when they were designed the equipment in use was undoubtedly lighter than the present day automobile truck. Notwithstanding this fact, they are today carrying as heavy traffic as any bridges in the country, and bid fair to continue to meet growing demands for many years to come. In view of the foregoing, the question naturally arises—did the engineers who designed and built these structures, foresee the possibilities of the wonderful growth in railroad traffic and realize what tremendous loads such structures would eventually have to carry? Whether they did or not, the bridges stand as monuments to the engineers in whose minds they had their inception. For many years they were in a class by themselves and they may never be surpassed.

A case illustrating a failure under Cause VI was described in the Engineering News Record of July 25, 1918, page 186-189, in which is given a report on the repairs of a washout under the Coon Rapids dam in the Mississippi river about 11 miles above Minneapolis, which occurred Sept. 1, 1917. The dam in question was of concrete construction, and extended across the Mississippi river, having a length of about 1000 ft., a height at the spillway of about 21 ft., with a width of base of 27 ft. 9 in. The material upon which it was constructed was a glacial drift formation. The south bank was a so-called hard-pan to a height of about 20 ft. above low water, but in reality it was a mixture of sand, gravel and clay, very hard in places, though easily crumbled in the fingers when broken off in small pieces. It was practically impervious to any head created by the dam. The material, however, had a decided dip to the north and after passing below the river bed it was overlaid by a deposit of clay containing a large percentage of fine sand. The clay deposit, extending in general from the river bed down to the hard-pan, was interspersed with pockets of sand of varying degrees of fineness. Near the north end of the spillway it was overlaid by a deposit of boulders and sand. The failure occurred in this vicinity.

To provide a safe foundation for the dam, wood piles were driven, with bearing values of 10 tons per pile. Cut-off walls of steel sheet piling were placed under the heel and toe of the dam, the sheeting being driven to such a depth as to penetrate at least 5 ft. into material that would be impervious at the head developed by the dam. This depth was determined by test borings, the maximum length of steel piles being 25 ft. A concrete apron extending 50 ft. beyond the toe of the dam, also supported by wood piles, was provided, in the toe wall of which was a line of 8-ft. steel sheet piling to prevent scour from cutting back under the apron.

A power house was located at the north end of the dam above described at the head of an island, in what was a north channel. Formerly this channel, being the deeper of the two, carried probably more than half the flow during floods, but after the plant was built practically the entire flood flow went over the spillway into the shallow south chan-

nel. This condition was a factor in the erosion which took place below the dam. It was assumed that with the high velocity in the south channel, due to its greatly increased discharge, there would be some scour until the river reëstablished a permanent condition of flow.

The dam and power house were completed in Jan., 1914, at which time the gates were closed. The spring flood of 1914, though not of large proportions, carried a quantity of logs over the spillway. Soundings made after the flood showed that considerable erosion had taken place, but not near the apron. It was therefore considered safe to await further developments.

The flood of 1915, considered to have been the maximum for this part of the river, amounted to more than 60,000 cu. ft. per second. Soundings made in the fall showed that irregular scouring had proceeded along the entire length of the spillway. The conditions were such as to make it necessary to provide protection before the next flood. Timber cribs about 24 ft. wide with their tops below the top of the apron were sunk against the toe of the apron for more than half the length of the spillway section.

Soundings made during the winter of 1916-17 showed that the cribbing had been damaged considerably, and that erosion had extended so that protection work of a more extensive character was rendered necessary. After studying the situation with the aid of a contour map prepared from soundings, it was decided that a coffer dam should be built around the hole during the following summer to permit the pumping out of the water and the placing of a concrete floor or paving, after the high water of 1917. This flood carried large quantities of logs and heavy ice over the spillway so that while the flood was not nearly as great as that of 1915 it probably caused more scouring than any previous one.

Construction of the coffer dam enclosing an area below the apron for about two thirds the length of the dam was started in June. On August 11, 1917, the hole was unwatered and by August 31 it was ready for filling with concrete. Up to this time no leakage or seepage had been observed coming from under the dam. However at 2 A. M. Sept. 1, the watchman noticed that the water in the hole was gaining on his pumps and he immediately reported it to the superintendent, but the flow developed so rapidly that the hole was filled with water before anything could be done to stop it, except to open the sluice gates and thus hasten the lowering of the dam level.

Steps were taken immediately to build a rough coffer dam of rock-filled cribs, faced with wood sheeting placed by hand, to obstruct the flow of water under the dam and thereby retard or stop the erosion. In the meantime the ends of the break were covered with brush and sand bags to prevent it from widening. Materials were also ordered for a more substantial coffer dam in the reservoir. Steel sheet piling was obtained from Minneapolis, Buffalo and St. Louis on rush orders and a coffer dam about 350 ft. long extending about 150 ft. up stream was constructed. The piling was driven to a penetration of about 30 ft. and was supported by rock filled cribs 16 and 24 ft. wide.

When the coffer dam was pumped out it was discovered that a hole about 200 ft. long had been eroded under the dam. This hole was about 26 ft. deep in the center and sloped up to the base of the dam at each end. The foundation piles were not undermined so that they sustained the load and no portion of the dam was lost or seriously damaged, nor was there any settlement or sign of distress. The two lines of sheet piling under the dam were not damaged but they were undermined at the break by the washout. Two 54-ft. sections of the apron collapsed because the shorter piles and sheet piling used under the apron were undermined.

In the original construction of the dam the sheeting and foundation piles where the washout occurred were driven from the ice before the coffer dam was built. The sheet piling was driven first. Con-

siderable difficulty was experienced on account of boulders and old logging cribs. There was some apprehension that these obstructions might split the webs of the piles or pull the interlock apart, but nothing of the kind was discovered. However, examination of the sheeting exposed revealed the fact that when one of the bearing piles was driven it had been set on the top of a steel pile, and while the former was badly split, it had nevertheless carried the head of the steel pile to the bottom of the adjacent piles, thus leaving a slot only partially filled by a wooden pile. This condition was either not discovered by the inspector when the excavation for bedding the heads of the steel piles was made or, if discovered, the defect was not remedied by driving a new steel pile. This opening through the cut-off wall is considered beyond doubt the cause of the accident.

Three plans for the repair work were considered, differing principally in detail, each of which presented its difficulties. The principal points to be determined were the bearing value of the clay and the possibility of constructing a new cut-off wall which would tie in with the old cut-off wall beyond the limits of the break. Plan A provided for filling the hole under the dam with 1-3-6 concrete, and facing this on the up stream side with 1-2-4 concrete, encasing the heads of the steel sheet piles of the new cut-off which was to be driven about 5 ft. up stream from the face of the dam. Plan B provided for a similar construction except that the concrete was to be a lean mixture approximating the adjacent hard-pan in rigidity. Plan C provided for a reinforced concrete mat under the dam, upon which cross walls were to be built to support the undermined portion with a reinforced cut-off wall on the line of the old steel cut-off, bearing against the ends of the cross walls and carried well into the underlying hard-pan. The spaces between the walls were to be filled with sand and the apron wall restored in its original form.

The objections to plans A and B were the increased weight and the difficulty of bonding the new cut-off wall with the old, to make it continuous and effective. The original steel cut-off was more than 2 ft. back of the face of the dam and as new steel could not be driven closer than 12 in. there would have been a gap of about 3 ft. between the two rows of sheeting. By slotting the face of the dam it would have been possible to turn the new line of sheeting at right angles to the axis of the dam and drive it up to the old sheeting, but no junction with the old sheeting would have been possible nor would there have been any assurance of contact between the two lines. Plan C would eliminate this difficulty.

Leakage of the coffer dam, however, was the deciding factor and plan A was adopted. The new cut-off wall, as driven, was 175 ft. long. The piling varied in length and was driven into hard-pan. The junction between the old and the new cut-off walls at the south end was effected by excavating a well between the end of the new and the face of the old, down to the bottom of the former. A section of the old sheeting was cut out by a blow torch and sufficient excavation was made behind the sheeting to get a good bond. The well was filled with concrete.

As the cutting of the sheeting and the excavation behind it was very difficult the method of making a junction at the north end was changed. An angle-iron was top-bolted to one of the piles in the old sheeting and the outstanding leg was embedded in the concrete. This method was much more easily carried out and resulted in more satisfactory work.

On account of the close spacing of the bearing piles, the placing of concrete was very difficult except in the bottom of the hole where it could be spouted. In the hope of getting the concrete so solidly packed that grouting would not be necessary, the pneumatic method was employed. Owing to inexperienced help, cold weather and adverse conditions generally the method was not entirely satisfactory. Some segre-

gation of materials occurred as the concrete was deposited, owing to difficulty in the manipulation of the outlet of the discharge pipe, on account of interference of the piles. Wearing away of the discharge pipe was another difficulty experienced. Notwithstanding the difficulties enumerated good work was done and it is considered that pneumatic placing was the only practical method under the circumstances.

In last year's report, reference was made to strengthening a section of the retaining wall between the Chesapeake and Ohio canal and the main tracks of the Baltimore and Ohio at Point of Rocks, Md., during the winter of 1912-13. This work was done by contract, and, to avoid interference with navigation on the canal, it had to be done during the winter when the use of the canal was suspended. This plan also reduced the cost of foundation excavation and masonry which otherwise would have had to be done in about 10 ft. of water.

The concrete plant was erected about 1,200 ft. east of the point where the wall was to be reinforced. The concrete was moved from the mixer to the work in narrow gage Koppel cars hauled by a dinky locomotive. As the railroad tracks were located within a few feet of the face of the wall to be strengthened, it was necessary to erect a trestle upon which to operate the dinky trains. In doing this, one end of the caps was supported on the wall and the other on posts resting in the bed of the canal. On account of having to do this work in mid-winter, the cost of placing concrete was considerably higher than if it had been done in warm weather.

The cost, excluding overhead charges, was as follows:

1,311 cu. yds. foundation excavation, @ $3,	$ 3,933
883 cu. yds. foundation concrete, @ $8,	7,064
1,560 cu. yds. neat concrete, @ $8,	12,488
23,200 lb. reinforcing steel, @ $0.04½,	1,044
Additional work—force account,	72
Refund of passenger fares,	239
Refund of freight charges on plant and material,	656
Engineering,	408
Total,	$25,904

During the winter of 1916-17 a second section of the same wall was reinforced, the work being done by company forces under the direction of S. C. Tanner, master carpenter. The work was begun on November 27, 1916, and completed March 17, 1917, and extended for a distance of about 1150 ft.

The concrete was all placed between January 4 and March 5, 1917, during the coldest weather of the winter, entailing considerable expense to protect it from freezing. Unlike the section reinforced during the winter of 1912-13, this concrete was placed without the use of any reinforcement. The average height of the new work, including foundations, was about 20 ft., and the wall required about 4 cu. yd. of concrete per lineal foot of wall.

The equipment consisted of one locomotive boiler and three 48-in. vertical boilers to furnish steam for operating the plant and heating the materials; two ¾-yard concrete mixers, so arranged that they would discharge into two cars at the same time, on either of two tracks, as might be desired to suit the trains of dump cars; one dinky and 20 dump cars. The concrete was moved to the work, by two 10-car trains, the greatest distance being 1,800 ft.

The stone and sand were dumped, as delivered, on standard equipment into the canal, and then hoisted by a derrick with a 75-ft. boom equipped with a clam shell bucket to the bins located under the mixers. Two bins were used for stone and one for sand. The bins were lined on all sides with steam coils, and exhaust steam from the mixers was passed through the coils, so that both sand and stone were thawed out

before entering the mixers. Live steam was used to heat the water, the result being that the concrete was discharged into the dump cars at a temperature of about 85 deg. during zero weather.

For handling the foundation excavation and moving the forms, which were built in 8-ft. sections, a track was laid in the bed of the canal, upon which was operated a mounted derrick. This equipment was also used to remove the dinky track, trestle work and forms upon the completion of the work.

The accompanying photographs will serve to better illustrate the methods employed, and the conditions under which the work had to be executed.

(Looking East) (Looking West)

Point of Rocks Retaining Wall. Mixing Plant and Storage of Sand and Stone in Canal

Point of Rocks, Md., Dumping Warm Concrete into Forms Near West End of Wall in Zero Weather

Excavating and Underpinning Last Section of Wall

Point of Rocks, Retaining Wall Completed

The following is a detailed statement of the cost of the work:

Erection of Plant—Labor

Clearing ground,	$ 54.00
Building track on which to handle material and equipment,	629.29
Loading lumber (at Locust Point),	89.14
Constructing cement storage houses,	81.21
Unloading lumber,	235.30
Constructing sand and stone storage bins	112.04
Erecting mixing plant (including platform for mixers, setting up mixers, bins for supplying mixers and house for storing cement),	657.92
Setting up derrick,	269.75
Setting hoisting engines,	57.24
Constructing coal bins,	15.14
Loading and unloading mixers,	42.61
Rearrranging mixers to suit local conditions,	54.46
Loading, unloading and erecting pumps and boilers,	495.26

Placing tank for water supply (including piping),	73.01
Loading, unloading and repairing concrete cars,	156.83
Loading, unloading and repairing dinky engine,	70.35
Constructing trestle on which to operate cars for placing concrete in forms,	1,886.19
Constructing sheds over pumps and boilers,	22.45
Trucking ties and rails,	17.30
Carrying water,	3.84
Placing heating coils in material bins and water tank,	241.56
Storeroom labor,	66.01
	$ 5,330.90
Supervision,	266.54
Total,	$ 5,597.44

Maintenance of Plant—Labor

Repairing hoisting engines and derrick,	$ 43.95
Repairing mixers,	96.90
Repairing tools and equipment,	151.14
Cleaning boilers,	10.42
Repairing boilers and pumps,	212.59
Repairing boilers (motive power department),	73.93
	$ 588.93
Supervision,	29.45
Total,	$ 618.38

Material Used in Construction of Plant

25 rolls ruberoid roofing,	$ 37.50
10 rolls tar paper,	12.50
Lumber,	160.38
54 kegs nails,	291.60
14 kegs boat spikes,	30.30
2 coils rope,	21.80
24 salamanders,	87.36
Steel cable,	10.48
2 governors for mixers,	40.00
Tools,	32.88
Camp supplies,	23.59
Boots,	101.52
Material (motive power department),	11.17
Pipe and fittings for water and steam lines,	332.24
Pipe and fittings for heating coils,	146.38
Repairs to mixers and boilers,	28.04
4,901 ft. usable 67-lb rail,	1,046.76
390 usable angle bars,	39.00
4 kegs track bolts,	20.00
1 frog,	20.00
1 switch complete,	25.00
Total,	$ 2,518.50

Concreting—Labor

Unloading sand,	$ 352.39
Unloading cement,	202.06
Unloading stone,	350.93
Unloading coal,	177.89

Trucking coal and cinders,	156.14
Operating mixing plant,	1,212.14
Unloading and placing concrete,	1,545.80
Operating derrick and supplying mixers with material,	573.41
Firing boilers,	357.07
Firing dinky locomotive,	189.06
Trucking cement,	267.76
Carrying cement to mixers account of disabled derrick,	158.09
Cutting into old wall for drainage,	26.90
Dressing finished wall,	6.39
Bundling cement sacks,	30.40
Carrying water,	94.98
Thawing pipes,	63.37
Thawing sand,	32.63
Firing salamanders,	217.12
Trucking coal for salamanders,	11.83
	$ 6,026.36
Supervision,	301.32
Total,	$ 6,327.68

Forms—Labor

Building, setting and removing,	$ 2,105.15
Supervision,	105.26
Total,	$ 2,210.41

Forms—Material

Lumber,	$ 558.00
Bridge washers,	10.00
Nails,	48.60
Wire,	81.16
Tar paper,	6.25
Total,	$ 704.01

Plant Rentals

Hoisting engine, @ $150 per mo.,	$ 479.02
Concrete cars, @ $1 per day,	204.00
Labor loading four concrete cars,	6.84
Derrick and clam shell bucket, @ $300 per mo.,	619.35
Loading derrick and bucket,	32.32
Locomotive, 58 days at $5 per day,	290.00
Concrete cars,	40.00
Slewing engine,	50.00
Freight on borrowed equipment,	75.43
Total,	$ 1,796.96

Dismantling Plant—Labor

Dismantling plant,	$ 1,114.96
Removing piping and pumps,	45.33
Loading equipment,	213.20
Cleaning canal,	178.71
Loading cement,	19.30

Loading stone,	45.07
	$ 1,616.57
Supervision,	80.83
Total,	$ 1,697.40

Material used in Concreting

5,269 bbls. cement @ $1.48,	$ 7,798.12
2,876 tons of sand @ $0.40,	1,150.40
3,220 tons of stone @ $0.47,	1,513.40
602 tons of coal @ $1.01,	608.02
	$11,069.94
Credit 20,132 empty cement sacks,	2,013.20
Net Total,	$ 9,056.74

Excavation—Labor

Loading and unloading ties for track on which to operate derrick car,	$ 11.83
Trucking ties for track,	16.24
Laying track,	214.92
Unloading buckets,	1.69
Repairing derrick car,	26.72
Excavating,	1,948.10
Removing track,	102.75
Removing derrick car,	32.60
Removing and burning old ties,	14.00
	$ 2,368.85
Supervision,	118.44
Total,	$ 2,487.29
Work train service (Labor, fuel and supplies),	387.06
Blue Line service,	1.65
Total,	$ 388.71

Credits

2,500 ft. 1 in. by 6 in. Y. P. lumber,	$ 37.50
2 governors,	20.00
Water and steam pipe,	180.67
Steam pipe from heating coils,	59.38
Water and steam pipe fittings,	29.04
Fittings from heating coils,	12.65
Boiler and machine fittings,	28.95
4,901 ft. rail,	1,046.76
390 angle bars,	39.00
4 kegs of track bolts,	20.00
1 frog,	20.00
1 switch,	25.00
Total,	$ 1,518.95

SUMMARY

4,476 cu. yd. of concrete placed at $6.57 per yd.
1,642 cu. yd. of excavation at $1.515 per yd.

Plant—		
Erecting—Labor,	$ 5,597.44	
Material,	2,518.50	
Maintenance,	618.38	
Dismantling,	1,697.40	
Work train service,	387.06	
Blue line service,	1.65	
	$10,820.43	
Credits,	1,518.95	
Net,	$ 9,301.48	
Cost per cu. yd. of concrete $2.08.		
Rental for borrowed equipment,	1,796.96	$11,098.44
Cost per cu. yd. of concrete $0.40.		
Concreting—Labor,	$ 6,327.68	
Material,	9,056.74	15,384.42
Cost per cu. yd. concrete $3.44.		
Forms—Labor,	$ 2,210.41	
Material,	704.01	2,914.42
Cost per cu. yd. of concrete $0.651.		
Excavation—Labor,		2,487.29
Cost per cu. yd. for excavation $1.515.		
Grand Total,		$31,884.57

Cost per Cubic Yard of Concrete—Various Items

Construction of plant—labor,	$1.250
Construction of plant—material,	.111
Engine service,	.087
Maintenance of plant—labor,	.138
Operation of plant,	.775
Dismantling plant,	.379
Mixing and placing concrete,	.362
Sand—material,	.257
Sand—labor—unloading,	.129
Stone—material,	.336
Stone—labor—unloading,	.082
Cement—material,	1.292
Cement—labor—handling,	.048
Coal—cost,	.136
Coal—labor—unloading,	.064
Coal—labor—trucking to boilers,	.036
Forms—labor—constructing, setting, etc.,	.494
Forms—material,	.158
Rentals on borrowed equipment,	.400
Charges incurred acct. winter work	
Installing heating pipes in material bins	
Material,	.020
Labor,	.067
Salamanders—cost,	.018
Labor—operating,	.054
Thawing pipes and sand,	.022
Total cost per cu. yd.,	$6.715

J. P. Canty, division engineer of the Boston and Maine, advises that their custom of repairing old stone masonry has been confined almost wholly to raking out the joints and pinning and pointing them, or in some cases simply pointing. When the masonry is in such condition

that this method will not be effective and economical it is torn down and rebuilt, although in some cases structures have been saved by buttressing and reinforcing bulging or otherwise defective masonry, with iron or concrete or both.

One case in which the above method was employed consisted of a comparatively large stone arch over a stream in which one flared wing about 75 ft. long, bulged to such an extent at the center about midway between the top and bottom, as to make the road uneasy about its safety. This wing was about 35 ft. high where it joined the spandrel wall of the arch and was stepped down from full height near the track, to a height of 4 or 5 ft. at the outer end.

In this case about 15 wooden piles were driven in two rows in front of the wing where the maximum bulge was located. These piles covered a rectangular area about 8 ft. wide and 16 ft. long parallel to the masonry. They were enclosed by a wood coffer dam, which was unwatered and the piles cut off at the water line. The coffer dam was then filled with concrete, and scrap track rails, set vertically at about 2 ft. centers, close to the old masonry, were embedded in it. A block of concrete was then cast, encasing the rails battering from the outside line of the coffer dam to a width of about 3 ft. at the level of the maximum bulge. No movement of the masonry has been noted since this was done about two years ago.

In another case, the crowns of a three centered double track stone arch bridge of two 20-ft. spans laid dry, began to flatten in the center of each arch. This structure was constructed over a stream with the track grade only 3 or 4 ft. above the crown of the arch rings. The abutments, pier and wings showed no evidence of movement or distress. Repairs to this bridge were made by building a temporary wooden deck under the tracks, supported on pile bents back of each abutment and a timber bent over the center of the pier to carry traffic. This construction permitted the removal of the earth filling and ballast from the tops of the arches.

Timber forms made to fit the original curve of the arches were placed under them and the deformed arches were jacked back to the original shape and position. All joints were washed out clean with a force pump and thoroughly grouted with cement. An examination of the structure disclosed the fact that the thickness of the abutments at the spring line was not sufficient to stand the thrust of the arches according to accepted practice and additional concrete was added to provide for this. The earth covering was then replaced on the arches and in the rear of the abutments and the false work removed. This work was done about 10 years ago and no settlement has since been noticed.

Stone masonry piers which showed evidences of failure have been repaired and strengthened by placing track rails in pairs, vertically on each side of them, tying them together by placing rods through the piers between each pair of rails, secured to the rails by heavy bent washers on the outside of the rails, with nuts on each end of the rods. The entire piers were then encased in concrete 12 in. to 18 in. thick and have since given satisfaction.

Repairs to high spandrel or parapet walls on old stone arches, carrying single or double tracks which have been pushed out by the increased weight of rolling stock, have been repaired by drilling holes in pairs through the spandrel walls opposite each other about 4 ft. below the tops of the ties, excavating trenches under the tracks opposite the pairs of holes and providing rods about 1½ in. in diameter with turn buckles in the center and nuts on each end. These rods were anchored to the faces of the walls by pairs of rails as above described, or by heavy iron plates set in the face of the masonry. The nuts and turn buckles were then screwed tight and the rods encased in concrete.

Repairs to concrete masonry have been made by cutting out the defective concrete and replacing it with good material.

A. S. Markley, master carpenter of the Chicago & Eastern Illinois, during the discussion of this committee's report last year presented a very complete report on repairs made to a number of structures on the lines of his road. This year he furnished notes on repairs made after a washout at bridge No. 1408 from which the following report has been prepared.

This bridge crosses the Vermilion river at Cayuga, Indiana. As originally constructed in 1871, it was a single track through truss bridge 178 ft. long. In 1903 it was converted into a double track structure by extending the pier 14 ft. on the down stream end. The extension to the pier was built of concrete, the foundation of which was carried to solid rock. The original pier, built of stone in 1871, was supported on piles about 14 ft. long, driven to rock, upon which was placed a timber grillage of the usual construction.

In 1913 a washout occurred which removed the sand and silt from between the piles under the pier and in addition, knocked out several piles. This permitted the pier to settle and crack. Traffic was immediately diverted to the north-bound track, which was supported by the 14 ft. extension resting on rock and which had not been disturbed. To prevent the total destruction of the old portion, if additional piles should fail, it was clamped to the new part by placing 1½ in. rods parallel to the sides of the pier, with timbers across the ends. By this process the old part was held firmly to the new and traffic resumed on both tracks.

A coffer dam of Wakefield sheet piling was placed around the entire pier. All loose material remaining between the piles and on top of the rock bottom was then removed, leaving a cavity about 11½ ft. deep by the horizontal dimension of the original pier, between the bottom of the grillage and the top of the rock. Using the walls of the coffer dam as a form this cavity was then filled with concrete, thoroughly grouted under the grillage. The concrete was then carried up around the outer edge of the grillage, sealing the concrete against the bottom course of masonry to the timber grillage.

The estimated cost of making these repairs was $2,000. The actual cost was $1,780.

In last year's report Mr. Markley gave cost data covering the strengthening of five piers and the south abutment of bridge 1634 over the Wabash river at Clinton, Ind., showing the cost of labor and materials for forms at $3.33 per cubic yard of concrete, and the cost of labor and material per cubic yard of concrete in place at $10.89. This year he furnished a detailed statement of the cost of repairing the north abutment of this bridge, which work was done at about the same time as that reported last year, as follows:

Concrete in foundation,	42.3 cu. yd.
Concrete above foundation,	210.0 cu. yd.
Total,	252.3 cu. yd.
Foundation excavation,	204.4 cu. yd.
Concrete in two bearing blocks,	18.5 cu. yd.
Cost of excavation per cu. yd.,	$0.833

Cost of Various Items per cu. yd. of Concrete

Forms (labor $1.868, material $1.499),	$ 3.367
Cement,	1.933
Reinforcing bars,	.946
Labor concreting,	3.177
Material concreting,	2.908
Setting reinforcing bars,	.214
Cutting and drilling,	.534
Bearing blocks,	5.106
Placing bearing blocks,	10.017

The average cost per cu. yd. of concrete was, labor, $6.775, material, $4.392, total, $11.167.

Recapitulation

Bearing blocks	Labor	Material	Total
Making,	$ 35.50	$ 58.97	$ 94.47
Placing,	166.90	18.41	185.31
North abutment,			
Excavating,	170.30		170.30
Forms,	471.41	378.25	849.66
Setting bars,	54.13		54.13
Cutting and drilling,	134.74		134.74
Concreting,	801.72	733.69	1,535.41
Totals,	$1,834.70	$1,189.32	$3,024.02

C. H. Fake, engineer maintenance of way, of the Mississippi River and Bonne Terre, seems to have been more fortunate during the past 22 years than most engineers occupying similar positions and your chairman is unable to determine whether to commiserate or congratulate him. It is feared he does not know what he has missed in not having a lot of poor masonry to repair or rebuild, this being a class of work often taxing one's ingenuity and resourcefulness to the limit to accomplish.

While it has been his good fortune to have had to make no repairs to masonry on the road with which he is now connected, he advises that prior to becoming associated with this present company he was for a few years with the Missouri Pacific, which has a great deal of poor masonry. When repairs to this masonry were necessary it was generally found to be in such unsafe condition as to require rebuilding. Its condition was due to one of two or three causes.

First, much of it was poorly constructed, laid with very close joints presumably in lime mortar, practically all of which had disappeared. The backing was not grouted or properly filled with mortar and while the face stones were reasonably well cut they practically rested on one another with no mortar bed between them. Second, the stone as a rule was local limestone which did not "weather" well and much of it cracked, either from weather conditions or poor bedding. Third, much of it was damaged by fires caused by the burning of wooden bridges during the Civil War, first, from the Confederate side and then from the Union side. The heat from these fires badly spawled the face stones of the walls and in many cases practically destroyed them. In some cases where the damage was not too great, the copings were removed, face joints pointed up and the body of the structure filled with a thin grout. In other cases damaged stones were removed and the spaces filled with concrete.

DISCUSSION

(Repairing and Strengthening Old Masonry.)

L. D. Hadwen:—The thing that impressed me most in the reading of this report was the fact that prevention is so much better than the cure. I think that while all the rest of the bridge structure undergoes a very rigid inspection, the masonry doesn't receive the same care and upkeep as the other parts of the structure. Frequently bridges are subjected to much heavier loads than those for which they are originally designed. The steel work is strengthened accordingly but nothing is done to the

masonry. Afterwards such defects occur as have been called attention to in this report. If, at the time the steel were strengthened, steps had also been taken to reinforce the masonry, no aggravated damage would result.

In this connection, nothing is mentioned in the report as read in regard to drainage back of the structure. A great deal of trouble with old masonry has been due to the fact that water gets pocketed behind the structure and causes damage. In many cases providing weep-holes in a high wall will prevent trouble from that water, particularly when the material used for backfilling is clay and material of that character.

A very effective way of repairing old masonry, as has been mentioned in the report, is by grouting but in many cases it is possible to jacket the masonry with reinforced concrete and to use some modern grouting plant whereby you can force grout throughout the structure possibly at a pressure of 100 or 200 lb., depending on the conditions.

I was surprised recently, in making repairs to a fine piece of bridge masonry, to find that, although it was built under first class specifications, it was possible to force quite a little grout into it by driving holes into the upper portion and using a grouting machine. In this particular case damage had resulted to the top of the pier. Repairs were made by encircling a few of the upper courses of the pier masonry with heavy rods which were tightened up by means of turnbuckles which went entirely around the course, the rods were encased in a jacket of reinforced concrete and after this reinforced jacket of concrete had set up, holes were drilled through the jacket and the body of the pier and heavy bolts run through to tie the masonry together.

Finally vertical holes were drilled in the top of the pier and the pier was grouted as mentioned previously. A very satisfactory job was the result.

Another phase of the repair problem has not been mentioned in the reading of this report. That is the possibility of reinforcing old culverts of rubble masonry and old arches by a concrete lining. In cases of this kind where a culvert is concerned we have found it better, if the water way conditions permit, to encroach a little on the waterway by cutting out somewhat on the side walls and building a reinforced concrete box capable of taking the load irrespective of the old masonry, letting the old masonry simply stay.

With respect to the bridges on the Missouri Pacific about two or three years ago I remember that Mr. Smith gave us some very interesting data in regard to the repairs which had been made under his supervision as consulting bridge engineer for the road. He emphasized the fact that many times instead of going to a very large expense and tearing out old masonry they had overcome the difficulty by making comparatively cheap repairs.

I think the tendency sometimes is to exaggerate the seriousness of the condition of old masonry; we condemn it and say we've got to pull it down when we really could carry it by devising some scheme of repairs. It seems to me that this is a point to be considered now when labor is so scarce and when we want to reduce our work to a minimum. We should try and carry old masonry structures rather than tearing them down and substituting something new.

Lee Jutton:—This question of repairing old masonry is one in which every railroad is undoubtedly very much interested. We all know that the motive power has been increased in weight, the load has been increased over structures and invariably the superstructure has either been reinforced or renewed with a heavier superstructure. That problem is not particularly difficult to solve but it is always a question what to do with the substructure. I believe that more expert inspection is necessary in connection with the substructure than with the superstructure. I believe, also, as Mr. Hadwen has said, that we often condemn old masonry a little too soon. I know that it is surprising what old masonry will carry after it has developed cracks and opened and settled a little bit, perhaps, but it still seems to do the work.

I want to mention one case of an old masonry arch built away back in the '60's. It was considered that this old arch should be encased in concrete as it was constructed of small and irregular stones and the mortar was coming out of the joints. It had been pointed and repaired and fixed up and plastered up; no particular weakness was visible but everybody agreed that the structure ought to be repaired and plans were made. It developed, however, that the farmer across whose land this road was running had a cattle pass there and held the rights to the bridge and he saw his chance to get a little money so he told us that he would not permit the reduction of the opening. That started us to thinking again and we decided that his claim was entirely out of reason and that he was not entitled to any consideration. After further consul-

tation it was decided to let the arch remain. It is a hard looking old structure, as I said before, but no particular weakness is evident and it is carrying the largest locomotives that we have in use.

Sometimes foundation matters are rather misleading and it is hard to determine just what to do with them. I had a little experience with a turntable foundation. It was on very hard clay which was practically impervious. It was tested with a load many times greater than the load that was to be put on it. Nevertheless, after the thing had been built it wasn't long until a little trouble developed at one corner. A good many attempts were made to save the structure but after a time it finally had to be blown up with dynamite and rebuilt.

I mention this merely to emphasize my original point that the handling of substructure problems, the strengthening of old masonry or the carrying of old masonry beyond the point where it might be first considered that it should be taken out is one that needs careful study. We all know that in these times of conservation we should give such problems very careful study and that before we make up our minds to tear out an old structure we should analyze it from every point of view. If that is done we will probably carry old structures over which otherwise we would have to replace.

W. E. Alexander:—Mr. Hadwen spoke about prevention being better than cure. I agree with that idea thoroughly. It has been said here in connection with the strengthening of old masonry that the backfilling and weep-holes in the walls have a great deal to do with the protection. I am located in a cold country where we have a great deal of frost and where the action of frost in the wet clay against masonry is very serious. We have found that the best backfilling against masonry or concrete walls or structures of any kind is locomotive cinders. They are porous and the water will work down and out if there is any chance.

F. E. Schall:—I want to say a few words in regard to what Mr. Hadwen said about grouting. We have done considerable work of this kind and we find it advantageous in walls that are very old to pick out four to six feet and drill in and grout that portion, then go up four to six feet more and drill in again to the heart of the wall and grout that. If the grout has to run for long distances it will choke up and you won't get quite as much benefit by trying to grout the entire structure from above.

In regard to the failing of old masonry, the principal defects that we have are the foundations. The old railroad pioneers did not go down deep enough or make the foundations wide enough. There is too much pressure on the soil. We have been underpinning our masonry with concrete in sections. We go right under the masonry 18 in. to 2 ft. and make it in sections only. We take out a section in the middle and then go about ten feet away and take out another section. In that way we can prevent our wall from tilting and at the same time underpin the structure.

As far as the motive power is concerned, the total weight of the masonry is usually so great as compared with the weight of the rolling stock passing over it that there is little danger of the masonry failing unless the foundations are bad.

P. J. O'Neill:—I have had a failure of a turntable by reason of the base of the foundation of the center being down in the clay and the impact of the engine rocking it, very slightly at first no doubt, but increasing as time went on. I remedied that by driving piles and inserting I-beams. This was a stone foundation and I think the trouble was caused by the fact that when we excavated into the clay and dropped stone in we simply made a clay pocket there to hold the water which gave an opportunity for it to puddle.

We have another turntable with a concrete foundation which we put in in a somewhat similar way though we haven't put any I-beams on it. We have cut it away at an angle of about 45 deg. and have filled it in with reinforced concrete. It is on a clay foundation somewhat similar to the other. We have poured concrete in and tried to fill the space absolutely, to allow no place for water to soak in unless it went through the clay which is practically impervious. We are hopeful that that will be successful, although we have no conclusive results as yet.

I would like to ask Mr. Hadwen what effect the 200 lb. pressure per inch on his grouting has had on the facing, the slab that is bolted on. Have you ever found that it was forced off?

L. D. Hadwen:—I have not used that high a pressure except where the masonry is very good.

A. Montzheimer:—Perhaps it might be of some interest if I would tell of the plan we followed in reinforcing the center pier of a drawbridge over the Grand Calumet river at South Chicago about a year ago. This pier supports a 240 ft. double track drawbridge and was built in 1869. At that time the river was

only about 16 ft. deep and the pier was built on a pile foundation. The piles were cut off under water, level with the bottom of the river. On account of the bridge being close to Lake Michigan it was difficult to get the piles cut off evenly, the wind causing rough water and making it difficult to get an even height for all the piles.

After these piles were all cut off a crib was floated on and the masonry built inside the crib; later the river was deepened so today we have about 22 ft. of water. The piles of course now project about 6 ft. above the bottom and have no bracing whatever, which caused a great deal of vibration. If a boat struck the center pier the whole structure would rock back and forth.

It was found necessary to do something and on account of the very heavy traffic there it was almost impossible to put the bridge out of operation. We therefore went in and drove steel sheet piling all around this center pier, widening it only about a foot on the channel side; although the ends of the piers were lengthened about 8 or 10 ft. Inside of this sheet piling we drove additional piles and later filled the entire cofferdam with concrete without pumping out the water. We secured a very fine job and I am satisfied that the concrete is just as good as though it had been put in within a dry space. On account of conditions there it was practically impossible to drive out the water.

We also put in a new turntable over the bridge which was done in, as I remember it now, about 72 hours actual time, the traffic being turned over another road while the turntable was being put in. Today we have practically a new bridge and all done without in any way tearing out the old structure. The results certainly warranted us in doing the work in that way.

J. P. Wood:—I was much impressed with one remark by Mr. Jutton. I believe that in times gone by too much attention has been given to tearing out old masonry where it could have been carried over. Because some of it started to go wrong or scour somewhat in years past, the idea with a great many railroads was to take it out and renew it whereas I believe the past year's experience shows that it would still stand for a number of years without any labor or material for reinforcing whatever.

We have a double 12 ft. brick arch at Ionia, Mich., erected about 1881, used for the purpose of carrying off overflow. During times of flood it carries water in great volume and also considerable ice in the early spring. The roadmaster called

my attention to it about six years ago at which time he said he thought it was in very bad condition. I made a thorough examination and was satisfied in my own mind that it would carry traffic safely for years without rebuilding or repairs. I examined that structure the past season and without any repairs I believe it is perfectly safe for several years more. With proper supervision and by the exercise of good judgment many structures may be carried for years with very little or no repairs.

The President:—The subject of repairing and maintaining old masonry is very important. I think in this connection that I might say a little in regard to Mr. Strouse's report on the Gwynns Falls bridge. I happen to have been connected with the repairing of that structure. In digging down to the foundation we found that this mammoth arch (and a beautiful one at that) was built on stone put on top of a double foundation with apparently no mortar whatever. We dug down and found an openwork—just a lot of stone put up and an acute arch put on top of it.

However it stood up until just about two years ago. I took it in hand at that time and built a wall outside on which to build a footing course. We pumped it full of grout which seems to have made a permanent job of it. As far as we can see it should now last indefinitely.

The walls along the arches and the parapets were finished smooth on the inside the same as the outside, and were put up as a protection to keep men from falling overboard and also as an ornament. From time to time the track was raised until it pushed the walls over, so we had to repair them. Their original line was straight and we tried to maintain the original construction.

This goes to show the fruits of the work of the track forces, raising track indiscriminately. There was no need to raise track there and if they had not raised the track all these years they would not have had to repair these walls. I think it would be a very good thing not to raise track over bridges of this character.

Those bridges were all drained when they were originally built. Holes were bored on several occasions to determine whether they were still solid. My attention was called to the fact that the bridges were falling because of the holes.

The work Mr. Strouse had in mind in his reference to the repairing of the old wall was on an old dry stone wall. As it was very close to the main track the wall became much shattered. While Mr. Strouse refers to this work being contracted, this

was not the case as I had supervision of it. We put all that concrete in there for 150 ft. of wall, averaging about 12 ft. high in 31 days, commencing the 4th of January and finishing the 5th of March. We came through without any frozen concrete and it protected and strengthened the structure until now it will apparently stand forever.

There is an old piece of masonry, an aqueduct on the Chesapeake and Ohio Canal, just west of Washington Junction, that has a break right in the middle of the arch, which has been there a good many years. The main arch is about a 30 ft. arch and has two small ones on each side, about 12 ft. wide. The main arch commenced to break down in the middle by the lighter arches giving away. They reinforced it by strutting it with timber. It leaks a little, but it is doing the business.

SOURCES OF RAILWAY WATER SUPPLY

COMMITTEE REPORT

Two essential features of almost equal importance must be considered in the selection of a railway water supply; quantity and quality. It is obvious that the supply must be sufficient in quantity, but secondary only to an ample supply is the question of quality.

The successful operation of a railroad using steam as a motive power requires that the supply of water be equal to the demand at all times. The consumption will vary greatly and the available supply should be sufficient for the maximum requirements with a safe factor to provide for future increased consumption. The quantity of water required is dependent on the number and size of the engines taking water, the tender capacity of the engines, the tonnage of trains and the distance between stations. Provision should also be made for water for other than locomotive supply at terminals and other points where such water is required. The immediate supply should be sufficient for a demand at least 50 per cent over the normal requirements to provide for fluctuations in consumption and extraordinary movements of trains following temporary obstruction of traffic or other reasons.

In considering a source of supply accessibility is secondary to the quality of the water. An ideal water for locomotives is one that will not form scale or cause corrosion, pitting or foaming. Unfortunately nature does not supply a water entirely free from these effects, but in many cases they can be minimized by a careful selection of the supply. Consideration should always be given to the quality of the water rather than to the convenience of location.

No figures are available as to the sources of water supply of American railroads, but the following statistics concerning municipal supplies are given by the U. S. Geological Survey, quoting from the Journal and Engineer, Vol. 24, No. 19, May 6, 1908: "In nearly 400 cities located in all parts of the United States and Southern Canada, 40 per cent of the public water supplies are drawn from wells; 25 per cent from lakes, ponds or springs, 24 per cent from rivers, and 11 per cent from mountain streams impounded or otherwise. In 56 out of the 93 cities in the Ohio River valley, and 46 out of 85 cities in the Upper Mississippi River valley water supplies are derived from wells. Of 131 cities in the New England and Middle Atlantic states 56 take their supplies from lakes or springs; 28 from wells; 26 from mountain brooks; and 21 from rivers. The total volume of water taken from other sources is, of course, greatly in excess of that taken from wells."

While municipal water supplies are used for domestic purposes rather than for boiler supplies, the various sources of municipal supplies may be taken as a fair average of the sources of water used for railway purposes, for the reason that the railroads are compelled to look to the same sources of supply as the municipalities through which they operate, in many instances taking their supply from the cities and towns along their line.

The water supply of any region, except the deep underground waters from porous beds which are supplied from a source perhaps many miles away, is abundant or deficient according to the character of the rainfall. Water falling as rain may be divided in three parts, (1) A part of the precipitation flows into the lakes and streams and to the sea. (2) A part is held by the vegetation and soil and is evaporated by the sun directly, or through plant growth. (3) A third portion is absorbed by the earth and penetrates the pores and fissures in the rocks, loose sands and clays below the surface, accumulating in the porous stratum from which it is secured by sinking wells.

The normal rainfall throughout the country has been estimated by the United States Weather Bureau at 29 in., and the area is divided in this respect into the following classifications: Deserts, or arid lands 10 in. per year; semiarid, or light rains, 10 to 25 in.; moderate, 25 to 50 in., copious, 50 to 75 in., and excessive above 75 in. According to the latest record less than 6 per cent of the area of the United States is in the excessive rainfall class, exceeding 75 in. annually, 16 per cent ranges from 50 to 75 in., 25 per cent from 25 to 50 in., 30 per cent from 16 to 25 in. and 20 per cent less than 10 in. It is upon these figures that the normal average of 29 in. per annum is based. The difficulty in providing an ample supply at all seasons from many of the streams and other surface supplies lies in the fact that the rainfall is not equally distributed throughout the year, and during the period of drouth, or of little rain, the smaller streams and water courses fail, often causing a heavy expense for hauling or securing water from other sources.

Streams

Small streams, if sufficient in quantity, present but few difficulties in establishing a pumping station. On rivers and the larger streams, where the stage of water varies beyond the limits of ordinary suction lift the proper location of pumps with reference to the varying stage of water is essential to satisfactory operation. The pumps are sometimes placed in water-proof pits within easy suction lift of the water at the lowest stage. Also facilities are sometimes provided for raising and lowering the pumps with the varying stages of the stream. The former method is decidedly the better one as, where the pumps are moved with the river stages, the station is little more than a temporary affair, and the costs of operation and maintenance are excessive. Streams usually carry considerable matter in suspension and the problem of protecting the intake lines from mud, sand, leaves, etc., is quite important. The matter carried in suspension by the water of streams may be removed readily by settling basins or filtrations, and the water is usually of a good quality except where the streams are polluted by sewerage or industrial wastes. Smaller streams are often affected by organic and vegetable matter, especially after a prolonged dry period followed by light rains which bring the troublesome matter into the streams, but do not flood the streams sufficiently to carry the impurities away. This condition accounts for a great deal of the trouble experienced from foaming and pitting, by water that is usually considered a good boiler water.

When the supply is from a small stream, whose normal flow falls below that necessary to supply the demand during certain seasons, it is frequently necessary to build impounding reservoirs in which to store the heavy spring and fall flows for use during the low periods of summer and winter. If the pump capacity is in excess of the flow, damming the stream will permit of securing the full supply by running the pump only a portion of the time, and at convenient periods instead of constantly.

Lakes

The smaller lakes and ponds usually offer the most favorable conditions for establishing pumping stations, both as to construction and quality of water. They are affected but little by storms, and difficulties from the effects of currents common with the larger lakes are not encountered. While the quality of the water of the large lakes is uniformly good the effects of currents and storms sometimes cause a great deal of trouble from turbidity and sewerage pollution, as well as stoppage of intakes, if they are located near the shore. Very few, if any, intakes of railway water stations are located very far from shore or breakwaters, and as the shores of lakes in the vicinity of cities are constantly being extended, chiefly through the dumping of rubbish, these intakes are a continual source of trouble and expense. The intake of one railroad

pumping station in Chicago, pumping from Lake Michigan, has been relocated four times and extended 200 ft. in 10 years. Where the water was 18 ft. deep 10 years ago, it is now 3 ft. deep and constant care is necessary to keep the intake from being covered by rubbish. During stormy weather or periods of inshore winds a large force of men is required to keep the intakes and strainers clean. As much as 20 tons of material has been removed from this intake in 10 hours. This condition has been brought about by the dumping of rubbish by the City and emphasizes the necessity of extending intakes well out in the lake, where they will not be affected by conditions along the shore.

Reservoirs

Impounding reservoirs are frequently found necessary for the storage of water when a suitable supply is not available from other sources. The most economical and satisfactory method of constructing an impounding reservoir is by damming up a valley if one may be found suitable for the purpose. The cost of excavating for a reservoir or constructing it entirely of stone, brick or concrete is prohibitive where the storage of several months' supply is required. Where the reservoir is dependent either on a stream or water shed for supply, the storage should be sufficient to provide for the evaporation and absorption that will take place in addition to the normal consumption. The evaporation will vary greatly with different reservoirs. The factors to be considered are, the humidity, area of reservoir, depth of water, temperature, proximity of forests and other local conditions. The absorption will depend entirely on the character of the surface and sub-strata, and unbroken sub-strata of clay or hard pan form the best possible bed for a reservoir as the absorption through a formation of this kind is less than through any other than an impervious rock. Where a limestone formation prevails, care should be taken to see that there are no sink holes or fissures in the submerged area through which the water might escape. The rainfall will have to be considered carefully in connection with the watershed to determine the catchment area required. The size of spillway will depend on the rainfall and catchment area and should be large enough to take care of the maximum run off over the entire catchment area.

The amount and distribution of the rainfall in the United States is given by M. L. Fuller in the U. S. Geological Survey Water Supply Paper No. 114, 1905, as follows:

"In the Eastern United States the rainfall is plentiful, the yearly average varying 20 to nearly 80 in. Rain to a depth of more than 60 in. a year falls on the Mississippi Delta below New Orleans and along the Gulf Coast from near Mobile, Ala., to Tallahassee, Fla. A nearly equal amount falls in the higher mountains of Western Carolina and Eastern Tennessee, along the coast of North Carolina and in the Adirondack and White mountains. In the Gulf and South Atlantic States the rainfall is between 50 and 60 in. a year, in the New England, Central Atlantic and Ohio River States, between 40 and 50 in., in the Upper Mississippi and Great Lakes States between 30 and 40 in., and in Northwestern Iowa and most of Minnesota between 20 and 30 in. In the Western part of the United States the distribution of rainfall is much more irregular than in the Eastern part. Westward from a line drawn through the Eastern part of the Dakotas, middle Nebraska, Western Kansas and Central Texas the rainfall decreases to less than 20 in. yearly, all of the Great Plains region being characterized by small rainfall. In the Black Hills, Bighorn mountains, and the higher sections of the middle chains of the Rocky mountains the rainfall is 20 or 30 in. yearly, and in the high Sierras, the Cascade, and the Coast ranges it is 70 in. or more, reaching a maximum of 150 in. in the Coast ranges of Oregon. In the Great Basin between the Sierra Nevada and the Wasatch mountains the rainfall is

less than in any other section of the country, in places being as low as 2 or 3 in. a year."

The care of the catchment area or watershed is an important factor in determining the quality of water secured from a reservoir. The most effective method of protecting the quality of an impounded water supply is to purchase the entire catchment area. This is hardly ever practical, or possible, the chief objection being the cost, as the water shed will usually cost many times more than the reservoir. The desired result may be accomplished in most cases by acquiring all the land around the reservoir within a certain distance of the water's edge. If this strip is kept well sodded it will assist materially in improving the quality of the water, as it acts as a strainer or baffle, and prevents impurities entering the reservoir. In preparing a reservoir site for water, it is very important that all timber and plant growth be removed from the flooded area to prevent contamination of the water through certain forms of vegetable life commonly known as algae.

The dam is perhaps the most important feature in connection with an impounding reservoir and too much attention can not be given to its construction. The foundation must be sufficiently firm to prevent the settling of the dam. The connection between the foundation and the dam must be of the best to prevent leakage and shifting, or sliding, as, if the connection is not good, a part of the dam may slide out under pressure. Dams are constructed of various materials such as wood, concrete, stone and earth. Earthen dams are most commonly used on account of their cheaper construction, and when properly built are quite as satisfactory as any other construction. There are several different methods of preventing leakage through, or under the embankments of earthen dams, the one most employed being a puddle wall carried from several feet below the base to the top of dam. The thickness of the puddle wall depends on the height of dam. Other methods of preventing leakage and strengthening dam are to drive a row of sheet piling through the center of the fill, or to construct a concrete core wall. Sometimes low retaining walls of concrete are placed along each toe of the slope, these walls assisting materially in preventing damage to the dam and adding to the appearance. The slope of the embankment will depend largely on the height, although it is usually carried 3 to 1 on the water side and 2 to 1 on the down stream side.

It is not the intention to devote any space to a discussion of the design of dams, as each installation will have to be considered in view of local conditions, the above being merely suggestions as to general practice.

Edward Wegman, writing on masonry dams in the American Waterworks Association Proceedings for 1913, gives the cause of failures of five high masonry dams as follows:

Year	Name	Location	Height	Cause of failure
1802	Puentes	Spain	164 ft.	Pile foundation
1881	Hobra	Algiers	110 ft.	High flood—poor masonry
1895	Bouzey	France	72 ft.	Pervious sandstone foundation
1900	Austin	Texas	68 ft.	High flood—poor foundation
1911	Austin	Penn.	50 ft.	Pervious foundation

It is interesting to note that in four of the failures above mentioned the cause was attributed to poor foundations. It is apparent that the success of a dam depends on the foundation quite as much as the dam itself.

Wells

A deep well is not always the most satisfactory method of securing water, as, where the head is far below the surface, the cost of raising the water is excessive, but surface conditions are often such that the only available water supply is that secured in this way. Well waters, as a

rule, are pure and clear, although many are very hard. A hard water is not objectionable for drinking purposes, but is unsatisfactory for boiler use. The majority of well waters respond readily to treatment and as a well is usually drilled only when all other possible water sources have failed, there is no choice, other than to use the water in its natural state or resort to treatment.

There is a great deal of superstition and guesswork among well drillers, and others, relative to the proper location of wells. A popular fallacy is the indication of water through the fancied movement of a branch or twig of a tree when carried over an underground water supply. It is also a common belief that the head of water increases with the depth of the well, or that flowing wells may be secured anywhere if the wells are sunk to a sufficient depth but experience has shown that the sinking of wells far below the principal water-bearing strata has commonly resulted in highly mineralized waters, rather than an increased head of flow.

An intelligent knowledge of the presence of underground water can be secured only by a careful examination of the locality in which the well is desired and of existing wells in the vicinity. From the existing wells and local geology, it is often possible to determine the exact depth of the water-bearing strata and the quantity of water it is possible to secure, as well as the quality of the water.

The ground water level has lowered decidedly in certain sections of the country. While this decline has not been confined to any particular section, it has been marked in Indiana, Southern Michigan, the Great Plains and in Southern California. It is also noted that an artesian well was drilled in Chicago in 1864 in which the water rose to a height of 80 ft. above the surface of the ground or 111 ft. above the surface of Lake Michigan. The flow in this well has long since ceased and the head has declined until the water stands 20 to 30 ft. below the surface, a loss in head of 100 to 110 ft. This loss of head may be accounted for in part through the reckless waste of ground waters from flowing wells. A great part of this waste is from the casings of old oil wells. In many sections of the country especially in Mississippi and Louisiana, hundreds of artesian wells are allowed to flow constantly to no purpose, wasting large quantities of the best ground waters. In the Southern States, with the possible exception of Florida, this waste does not appear to have materially affected the ground level of the water, but it is only a question of time until the loss will be seriously realized.

The following discussion on the amount of available underground water is taken from U. S. Geological Survey Water Supply Paper No. 257, entitled "Well Drilling Methods, 1911," by Isaiah Bowman.

"In most cases it is necessary to penetrate some distance below the earth's surface in order to reach a zone saturated with water, the actual depth depending on the amount of precipitation, the character of the rock, and the topography. The depth is least in regions of much rainfall and is greatest in arid regions. In general it is least in valley bottoms and greatest in the higher lands. In some localities, as at springs and in marshy lands, the plane of saturation coincides with the surface, but the existence of ground water at the surface is due to exceptional conditions. The lower limit of penetration of water depends on a number of conditions. The limit to which water will penetrate is the depth at which the weight of the overlying rock becomes so great that pores between the particles can not exist. This depth has been theoretically placed at about 6 miles. Practical experience in well drilling, however, does not prove the assumption that all rocks are saturated below a moderate depth. In the Pennsylvania and New York oil regions, for instance, rocks that are practically destitute of water are encountered at a depth of only a few hundred feet. These rocks include coarse grained sandstones capable of holding large amounts of water, yet as far as can be determined they are quite dry, so that it is necessary in

some wells to pour in from the top the water required in drilling. In some parts of these oil fields, the drill enters rocks containing salt water after passing through these water-free rocks, but fresh water is very rarely found below the dry rocks. In some places wells have been drilled several thousand feet without encountering water below the first few hundred feet, but, although the rocks thus penetrated are far from being saturated, they doubtless hold slight amounts of moisture. These facts show the fallacy of the popular idea that there is plenty of water if one only goes deep enough, and that great underground lakes exist.

"Although the depth to which water penetrates in large quantities is much less than is frequently assumed, the ground contains an enormous amount of water. Many estimates of the amount of ground water have been made, all of which take into account only the free water (that which is, or might be available for pumping purposes) and do not include that which is contained in moist clays and other materials, and is not readily yielded to wells. These estimates have become more and more moderate, ranging from that of Delesse made about 1860, which showed a layer sufficient to cover the surface of the globe 7,500 ft. deep, through that of Slichter (1902) which showed a similar layer 3000 to 3500 ft. deep and of Chamberlain and Salisbury (1904) which gave a layer 800 to 1600 ft. thick, to that of Fuller (1906) which shows that the amount of water available in the earth's crust is sufficient to form a layer over the surface of the globe, a little less than 100 ft. deep. This amount is equal to about one hundredth part of the volume of oceanic water."

The various types of wells commonly used in railway water service are: Hydraulic rotary wells, Standard drilled wells, Jetted wells, Bored wells, Driven wells, Open wells.

The hydraulic rotary process consists of rotating downward a string of casing with a toothed cutting shoe on the lower end. The weight of the casing on the shoe grinds and cuts away the material that is being penetrated, and the particles are carried to the surface by the water which is pumped through the casing and rises on the outside between the casing and the wall of the well. This method of drilling is very rapid in soft materials, and can be adapted readily to alternate beds of hard and soft material, the harder materials being penetrated by a drill. The process is, however, very satisfactory where the soft materials predominate, and in such materials the operation is practically continuous.

The disadvantage of hydraulic rotary drilling is that a large quantity of water is required, the amount depending on the porosity of the materials encountered. There is also danger of passing through water-bearing stratum without recognizing the presence of water, especially when mud laden fluid is used. The records of rotated wells are always more or less inaccurate owing to the difficulty of recognizing the different formations as soon as they are entered.

Standard Drilled Wells

The standard method of drilling wells probably originated with the churn drill used in China centuries ago. This method is used only when penetrating rock or other hard material and consists of raising and dropping a heavy drill against the rock. The drill is rotated by hand for the first 200 ft. or so to insure a round hole, after which the wind or twist of the cable changes the position of the drill automatically with each stroke. The cuttings of the drill are removed by means of a sand bucket which is constructed with a valve in the bottom which opens as the bucket is lowered, and closes as it is raised. Standard drilling is not continuous as with rotary drilling, as the string of tools has to be removed frequently to clean out the hole and change bits. It is costly and requires an expensive outfit as many difficulties are encountered in deep drilling. The string of tools is frequently lost and it

is necessary to maintain an outfit of fishing equipment to recover lost tools, the fishing operations in many wells taking more time and causing more expense than the actual drilling. The advantages are that it is adapted to drilling in all kinds of rock, is not limited to any ordinary depth, a good record of strata and water beds may be kept and all satisfactory water bearing strata may be utilized.

Jetting Wells

The jetting process for the sinking of wells might be called a combination of the standard drilling and hydraulic rotary processes, in a modified form. The jet consists of a drill on the lower end of the pipe with openings to allow the water to escape. The drill loosens the consolidated materials and the water washes the cuttings out of the hole. As with the rotary process jetting can only be done in soft material. Jetted wells are limited in size and can be sunk only to a moderate depth. The method is very rapid in soft materials and is much cheaper than the rotary and other drilling methods.

Bored Wells

Bored wells are from 12 in. to 3 ft. in diameter and are sunk with an earth auger turned by hand or by horse power. The auger is lowered into the hole and turned around until filled with material when it is raised by a windlass or block and fall and emptied. The well is usually cased with wood or tile. This type of well is limited to a depth of 40 or 50 ft. in most localities and as a result is dependent on the strata lying near the surface and seep water. Such a well is subject to contamination, stagnation and frequent failure during drouth.

Its advantages are that it is constructed cheaply by unskilled labor and with very little expense for tools or curbing.

Driven Wells

Driven wells are of two types. The first, and most common type is made by driving a strainer and drive point down to the water bearing stratum. The water level in a well of this type must be within 25 or 30 ft. of the surface as the drive pipe is too small to permit of lowering a cylinder to the water level. On larger driven wells the casing is fitted with a drive shoe and is driven down to the required depth, the strainer placed in position and the casing pulled back until the strainer is exposed to the sand. In driving the pipe the material is kept out of it with a sand bucket.

Open Wells

An open well is merely a matter of excavation and curbing. It can only be sunk to a comparatively slight depth except at a very heavy expense. The supply is limited to seep water and such sources as lie near the surface. The well requires frequent cleaning, and can not be depended on during periods of drouth.

The cost of drilling wells varies with the size, depth, kind of well, material, etc., to such an extent that no figures on cost may be given that would be of any particular value. As an illustration of the difference in cost of drilling under varying conditions, a number of deep borings are given, together with the cost. These borings include the deepest wells in the world.

1. Coalings, California. Well 2,890 ft. deep. The well was carried 20 in. in diameter for 2,000 ft., followed by 12 in. and finished 10 in. The drilling operations extended over a period of 9 years, and the cost is said to have exceeded $150,000.

2. Two and one-half miles west of West Elizabeth, Pa. Well 5,575 ft. deep, from 10 in. to 6¼ in. in size, cost $40,000.

3. Six miles west of Los Angeles, California. Well 5,660 ft. deep, from 16 in. to 4¼ in. in size. Cost approximately $100,000.

4. Schladeback, near Leipsic, Germany. Well 5,735 ft. deep, from 11 in. to 1.3 in. in diameter. Cost $53,076.

5. East of Rybuick, Upper Silesia, Germany. Well 6,572 ft. deep, from 3.6 in. to 2.7 in., cost $18,241.

6. Czuchow, Silesia, 7,347 ft. deep. This hole cost $80,082 and was given (1913) as the deepest borehole in the world.

(1-3-5, Oil City Derrick)

(2-4-6, U. S. Geological Survey)

C. R. KNOWLES,
Chairman.

WOODEN TANKS

By C. R. Knowles, Superintendent Water Service, Illinois Central Railroad

While discussions of steel and concrete tanks occupy a place in the great mass of engineering literature, it is surprising to note that but little has been written on the subject of wooden tanks, notwithstanding the fact that the wooden tank antedates both the steel and the concrete tank by many years. It is apparent that wooden tanks have been neglected by writers on engineering subjects except to the extent of publishing certain specifications and designs. The subject appears to be a timely one in view of the present steel situation and the fact that the concrete tank has not been developed to such an extent that it can replace either steel or wood entirely in tank construction.

Within the past few years steel tank construction had reached a point where it had largely supplanted the wooden tank on railroads on account of the low cost of production, improvements in design and the increasing scarcity of suitable timber. The unprecedented conditions growing out of the world war have resulted in greatly increasing the cost of steel tanks and this increased cost and the uncertainty of delivery have compelled many railroads to again give consideration to wooden tanks. Although conditions relative to the available material for wooden tanks have not improved there seems to be sufficient material to supply the demand and while the price has shown an increase in cost it has not kept pace with the cost of steel plates. A surprising feature of the situation has been the fact that the manufacturers of wooden tanks do not appear to be alive to the situation and the opportunity to push their product. In spite of this apparent apathy on the part of the wooden tank manufacturers there has been a decided increase in wooden tank construction on railroads which has been further augmented by the ruling of the Railroad Administration prohibiting the use of steel plates for the construction of water or oil tanks, except in high tanks where steel is essential.

The wisdom and necessity for such a ruling is at once apparent to all who realize the present shortage and need of steel in carrying on the war, yet the railroads generally do not seem to be aware of that fact as is shown by a circular from the Southern Regional Director dated Sept. 16 quoting a letter from the Priorities Committee of the War Industries Board to the Central Advisory Purchasing Committee stating that applications from contractors for priority on steel intended for the construction of railroad water tanks have been declined and that "It is to be regretted that the railroad companies generally have not yet realized the shortage of steel." The letter further states that manufacturing concerns are being required to use wood or concrete, not only for water but for the storage of fuel oil. The circular adds that all concerned should understand that applications will not be approved by the Priorities Committee for the construction of steel water and oil tanks and that the construction of such tanks must be confined at present to wood and concrete. That there is some question as to the suitability of concrete for the construction of water tanks generally is shown by a letter from the Northwestern Regional Director to the Northwestern railroads requesting information relative to concrete tanks. The letter requests specific information as to the length of service, and condition of tanks, and details of maintenance and cost, if any. It also calls for information as to the effect of climatic conditions on tanks now in use, admonishes the railroads to "Bear in mind particularly

the effect of freezing temperatures," and closes with a request for the recommendations of the railroads as to the use of concrete for the construction of water tanks.

The increased activity in the construction of wooden tanks, together with the growing demand in other lines for timber formerly used in tank construction naturally resulted in greatly increased costs and scarcity of suitable tank timber, especially for the larger sizes of tanks. The result has been that cheaper timber of shorter life is being used and the standards of wooden tank construction have been materially lowered. The solution of the problem appears to be the use of treated timber for the construction of tanks where suitable timber is not available; at least until the present world war is brought to a conclusion.

Timber Suitable for Tanks

The subject of timber suitable for wooden tanks will be dealt with lightly here as the committee report on railway water tanks in the 1915 proceedings of the Association goes into the question of tank timber extensively and but little can be added at this time. At the time the 1915 report was written cypress predominated as a tank material, while at the present time redwood probably predominates with Douglas fir a close second, although cypress is still being used to a large extent, but at a greatly increased cost. Heart red cypress, of course, leads all available timbers in tank construction for long life although the scarcity of this admirable timber is growing more apparent year by year. Redwood is beyond a doubt second only in permanency to cypress; in fact many engineers on the Pacific coast maintain that redwood is as durable as cypress for tank construction and point to redwood tanks 40 years old and still in service as verification of their claims. Douglas fir and southern heart pine are about of equal value as tank material with a life of approximately 10 years.

Development of Construction

Wooden tanks are generally built circular in form as this shape is more simple and economical in construction than any other form, the simplicity and economy being chiefly in the reinforcing required. A rectangular tank would probably not require any more framing than a circular tank, but would require a great deal more reinforcing than a circular tank of the same capacity, although many rectangular tanks have been built.

The Philadelphia & Reading at one time adopted as its standard, a rectangular or box tank, 15 ft. wide, 29 ft. long and 8 ft. deep inside measurements. The capacity was 26,000 gal. The advantage claimed for this style of tank was that it was cheaper to build than the circular tank and did not require as high a class of labor for erection. While this may have been true a few years ago when labor, lumber and iron were cheap, the opposite is the case today and square tanks are rarely constructed except in small sizes for emergency stations where material is not available for the construction of circular tanks.

There has been but little change in the design of circular wooden tanks since their first construction, as it is obvious that this type of tank will permit of but slight modifications, although there has been a wide variation in size, the capacity increasing with the greater demand for water and the necessity for additional storage. The only marked change in wooden tank construction from the earliest form to the present type has been that of eliminating the taper of the staves. Up to within a very few years ago all wooden tanks were constructed with tapering staves, making the tank smaller at the top than at the bottom, the original reason for this being that the hoops were not provided with lugs and bolts, but were riveted to the required diameter and driven down on the taper of the tank until they were tight as in driving a hoop on a

barrel. The sectional hoop with lugs and bolts replaced the solid hoop as it was found more satisfactory, especially for the larger tanks. The sectional hoop eliminated the necessity for tapering tanks, and the great majority are now built with the top and bottom of the same diameter, although a few roads have clung to the taper tank, probably from force of habit.

There have, of course, been certain modifications in the design of staves, hoops, etc., that have not materially changed the design of the tank. One of these is a non-shrinking stave, being made with a deep channel or groove in the top. This groove is filled with water from the pump discharge, which passes into the pores of the wood, keeping the top of the staves moist even when the tank is only partly filled and preventing shrinkage.

Sizes of Tanks

Wooden tanks are commonly constructed in practically all sizes up to 30 ft. in diameter and 20 ft. staves, and in some few instances in larger sizes. A 20 ft. by 30 ft. tank with a capacity of 100,000 gal. would appear to be the economical limit. If it is desired to build a wooden tank of greater capacity than 100,000 gal. the increased capacity should be gained by increasing the height of staves rather than the diameter of the tank. The longer stave would require more hoops and closer spacing, while an increased diameter would require thicker staves and bottom plank to maintain the required factor of safety, and if a much greater diameter were obtained bracing of the staves would be required to preserve the circular shape of the tank, as the pull of the hoops has a tendency to flatten the walls and throw the tub out of shape. Also the additional load would require a stronger tower. The additional cost of storage per thousand gallons would probably be more than if two or more tanks were constructed. Therefore, it is generally conceded that the construction of units within a capacity of 100,000 gal. represents the most economical construction. There is also a certain advantage in having two or more tanks as one tank may be taken out of service while being cleaned or repaired, without interruption to service.

Decay of Tanks

When the fibres of the wood comprising a tank are thoroughly saturated with water, decay is practically impossible; on the other hand if the wood was perfectly dry there would be little likelihood of decay. In water tanks, however, there is always an intermediate condition of moisture in which the wood is dry on the outside and wet on the inside, thus promoting rapid decay unless the timber has been carefully selected and has a relatively long life.

It is difficult to point out any portion of the tank more susceptible to decay than another, although decay in the tops of the staves is more noticeable, and the timber probably decays more quickly here than in any other part of the tank. If this is true it is very likely caused by a wider variation in the degree of saturation owing to the tank being filled and emptied. One of the arguments put forth in favor of roofs on tanks is the protection given the tops of staves. The advantage of a roof in the prevention of decay in the staves is extremely doubtful, as the only function it can perform is to keep the staves dry, which is obviously impossible in a tank used for the storage of water. To repeat a former statement, the most effective method of preventing early decay in wooden tanks is the careful selection of timber having a relatively long life or treating the timber to prevent decay. Poor inspection of timber is responsible for much of the decay in wooden tanks. A few poor staves in a tank will cause trouble even if the remainder of the staves are perfect.

An interesting feature is brought in connection with a 16 ft. by 24 ft. white pine tank taken down after 30 years' service. It was necessary

to renew the entire tank, but it was found that the staves on the north side of the tank were in much worse condition than any of the rest; the reason for this is given that the north side was always shaded which allowed moss to accumulate and assist decay. Another instance is quoted where heart cypress with an ordinary life of over 30 years failed from decay in 15 years owing to water shortage causing the tank to remain dry at periods several times each year.

Creosoted Water Tanks

The Illinois Central has recently started to use creosoted timber in the construction of its standard wooden water tanks. Nine of these tanks constructed during the past year proved so successful that this road is now building more and has practically made the creosoted tank its standard. Creosoted tanks were resorted to on account of the high price and great demand for steel for other purposes than tank construction, and the scarcity and cost of timber that would be suitable for use without treatment.

Although there are many different timbers commonly used in the construction of water tanks, there are but few available in suitable sizes and lengths to be used in the construction of large tanks, and when the life of the timber is considered this list may possibly be reduced to two,—cypress and redwood. The great demand for these timbers has been such that the price has advanced rapidly and suitable lengths are difficult to obtain. Undoubtedly the timber situation will grow worse as the war continues. Thus the use of lower grade timber that will take treatment readily appears to be a timely move.

The creosoted tanks built by the Illinois Central are of their standard sizes, of 100,000 gal. capacity with a 20 ft. stave and 30 ft. bottom, and 50,000 gal. capacity having a 16 ft. stave and a 24 ft. bottom, no change having been made in the plans formerly used for the construction of untreated wood tanks. The timber used is loblolly pine, coming under the general specifications for tank timber except that no restrictions are made as to heart or sap. The timber is air seasoned and should be permitted to season for three months in favorable weather. The method of treatment employed is the Rueping process, using about 5 lb. of oil per cu. ft. of timber. The oil used is a coal tar creosote, coming within American Railway Engineering Association No. 1 Specifications. The tank towers, constructed of 12 in. by 12 in. posts and 6 in. by 8 in. braces, roof, frost box, ladder and all timber entering into the complete structure is creosoted.

A very important feature in the construction of these tanks is that all timber more than 1 in. in thickness is framed before treatment, to secure the maximum life from the treated timber. The work of framing the tank before treatment is given such careful attention that it is rarely necessary even to bore a hole in the treated timber during the field erection of the tank. The work of framing and treating is done by company forces at the Grenada, Mississippi, creosoting plant. The tanks are erected by line gangs. Thus, in the manufacture and erection of these tanks the Illinois Central is independent of outside forces except the mills which cut the timber and ship it to Grenada in the rough.

When one discusses creosoted tanks for the storage of water the question is immediately raised as to the effect of the creosote on the water. In the tanks construction on the Illinois Central the presence of creosote in the water has been so slight as to be hardly noticeable and it has had no detrimental effect whatever upon the water. The Bureau of Industrial Research of the University of Washington conducted extensive tests of creosote wood stave pipe to determine its effect upon water for domestic and irrigation purposes. The test was conducted to determine the effect upon water carried by a 56-in. creosoted wood stave pipe line 22½ miles long, from the Landsberg intake

on the Cedar river to the Volunteer Park reservoir in the City of Seattle. In conducting the experiment a smaller pipe was used but care was exercised to have the conditions in the experiment representative of those existing in the larger pipe lines. The conclusions of the Bureau were that there was no detrimental effect of the creosote on the water. These conclusions were borne out fully by the results on the Illinois Central and the creosoted tank has proven an unqualified success.

Frost Proofing

A wooden tank is in itself a certain protection against frost. No frost proofing is required for the tank proper throughout the greater portion of the country and in few cases is any required even where the most severe cold weather prevails, providing the consumption of water each 24 hrs. equals the capacity of the tank. This, of course, applies only to the tank, as the inlet and outlet pipes will have to be protected against frost where a freezing temperature exists. The most effective frost box is one constructed with one or more air spaces. The walls should be of dressed and matched lumber and lined with building paper to make them as air tight as possible. More frost protection is always required where surface water is used than with water from wells as the temperature of well water is usually above 50 deg. F., while the temperature of surface water is often only slightly above the freezing point.

No set rules may be applied to frost protection as weather and other conditions vary so widely throughout the country that uniform practice is out of the question. The factors governing are: (1) Source of supply and initial temperature of water. (2) Minimum temperature prevailing and duration of temperature below freezing, always remembering that a temperature of 20 degs. below zero maintained for two weeks offers a far more serious problem in frost proofing than 40 deg. below for two days. (3) Size of inlet and outlet pipes, and whether flow of water is continuous or intermittent. (4) Consumption of water in relation to the storage capacity of tank. Wherever possible artificial heat should be dispensed with as stoves are responsible for more than 50 per cent of the tank losses from fire.

Fire Risk

While a wooden tank may be destroyed by fire as readily as any other frame structure when exposed to a fire hazard it is not the great fire risk that it is popularly supposed to be. An analysis of the tank fires occurring over a period of ten years on a railroad having 341 wooden tanks in service is as follows:

Number of wooden tanks	341
Insurable value	$591,517.00
Average insurable value per tank ..	1,734.60
Total fire loss ten years	22,635.52
Average loss per tank, per year	6.64
Percent loss to total value	.38

During this period there occurred 17 tank fires, 10 of which resulted in the total loss of the tank or an average of one each year which would indicate that the chances of a tank being destroyed by fire are in a ratio of about 1 to 350.

While the record of tank fires given above is not one to be proud of it is probably representative of the railroads of the country although it is expected that the loss can be kept well below the above figures by making a careful analysis of the causes and applying preventive measures.

Analysis of the causes of the fires is as follows:

6 fires caused from	thawing pipes	Total loss		$11,780
3 " " "	overheated stoves	"	"	4,850
3 " " "	sparks	"	"	2,775
1 " " "	cleaning lamps	"	"	1,700
1 " " "	tramps	"	"	1,500
2 " " "	foreign exposure	"	"	29
		Total		$22,635

It will be noted that 52 per cent of the losses were caused from thawing frozen pipes, 21 per cent from overheated stoves used to keep the tanks and pipes from freezing and 8 per cent from cleaning lamps under the tanks, or a total of 81 per cent of the losses may be charged directly to carelessness. If we include the fire caused by tramps we have a loss of $19,830 or 88 per cent of the total in ten years for which no reasonable excuse may be offered. It is interesting to note that 13 of the fires occurred during the winter months, 4 in November, 3 in December and 6 in January, with a loss of $19,830, or nearly nine tenths of the total, indicating that the danger from fire is almost wholly confined to the winter months and that protection from frost is also a protection against fire.

Life of Wooden Tanks

A letter of inquiry requesting information as to the life of wooden tanks was sent to 45 railroads and 27 answers were received. While much valuable information was obtained from the replies to the letters, the figures and estimates given as to the life of tanks were almost as many as the replies received. It should not be assumed that the figures given for the life of tanks were incorrect as the information submitted was undoubtedly as accurate as it was possible to give.

The variation in the figures submitted on the life of timber on various railroads goes to show that no accurate estimate may be made on the life of tank timber that will apply to all sections of the country. It is characteristic of timber that it is more durable when used in the region in which it is grown than when used elsewhere, for nature seems to have fortified the timber against decay to a certain extent when it is kept in its native climate.

One railroad reports 77 redwood tanks in service in California ranging from 26 to 48 years old, while another road reports redwood tanks renewed in Wisconsin after only 15 years of service. Twelve white pine are reported in service in Michigan with an average life of 35.4 years, while it has been necessary to replace white pine tanks in Missouri after 12 to 13 years. A Texas road reports cypress tanks in service as follows:

5	tanks	31	years	old
8	"	30	"	"
3	"	29	"	"

while several eastern roads fix the maximum life of cypress at 25 years.

A tabulation is submitted herewith showing the life of 310 tanks, 184 of which are still in service and 126 of which have been relieved. In preparing this tabulation only figures were used where the definite life of the tank was given. The lack of definite information as to the life of tanks as given in these letters shows the necessity of keeping more accurate records of the tanks in service than has been the practice in the past. The tabulation is as follows:

AVERAGE LIFE OF 184 TANKS IN SERVICE

Redwood

Railroad "A" 77 tanks Average life 32.6 years

Cypress

Railroad	"B"	29	tanks	Average life	28.3	years
"	"C"	25	"	" "	25	"
"	"D"	3	"	" "	32	"

White Pine

Railroad	"A"	24	tanks	Average life	29.7	years
"	"E"	12	"	" "	35.4	"
"	"F"	4	"	" "	29	"

Seven Railroads 184 tanks Average life 30 years

AVERAGE LIFE OF 106 TANKS RELIEVED

Cypress

Railroad	"B"	24	tanks	Average life	27.3	years
"	"G"	16	"	" "	30	"
"	"D"	3	"	" "	32	"
		43			29	"

White Pine

Railroad	"H"	27	tanks	Average life	27.5	years
"	"B"	22	"	" "	25.8	"
"	"I"	14	"	" "	23	"
"	"F"	4	"	" "	29	"
"	"D"	3	"	" "	33	"
"	"E"	3	"	" "	38.3	"
"	"C"	5	"	" "	27	"
		78		Average life	27	"

(See further reference in second paragraph following)

Yellow Poplar

Railroad "C" 3 tanks Average life 30 years

Red Cedar

Railroad "C" 1 tank Average life 28 years

Yellow Pine

Railroad "C" 1 tank Average life 29 years

Eight Railroads 126 tanks Average life 28 years

Summary

It will be noted that the white pine tanks show a higher average life than the cypress tanks in the table of tanks still in service while the opposite is true in the table of tanks relieved. This may be explained by the fact that cypress tanks were not used as extensively as white pine tanks up to 20 years or so ago, and on the roads shown there are

probably many white pine tanks which were in use before cypress tanks were constructed, although there is apparently very little difference in the durability of the two woods.

It is interesting to note that a yellow pine tank is shown with a life of 29 years while the life of a yellow pine tank as constructed today would probably not exceed 12 years. This difference in life can probably be explained in the fact that the trees from which the tank mentioned was cut had not been bled of the rosin and preservative oils natural to the wood. It should be explained that the life of 28 years given the red cedar tank did not represent the extreme life of the timber as when the tank was taken down the best of the timber was used in the construction of a smaller tank which is still in use. The original tank was constructed in 1870 which makes the timber in the smaller tank 48 years old.

In the letters received many records were given showing a life of only 10 to 15 years for cypress, white pine and redwood tanks. This was unfair to the timbers mentioned as the short life obtained was undoubtedly due to poor selection of timber, poor construction, the tank not being kept filled with water or some one or more of a number of faults that would cause early decay.

Hoops

A very complete report on tank hoops will be found in the proceedings of the Association for 1910 and little may be added at this time except to offer a suggestion that consideration be given to the standardization of tank hoops. Tank hoops in general use are principally confined to four different shapes,—round, half round, oval and flat. Even when a road adopts a certain shaped hoop it may not be of the same dimensions as the hoop used on another road. It would appear that flat hoops would be fairly uniform in dimensions but there is probably more variation in flat hoops than any other shape. In thickness they range from ⅛ in. to ⅜ in. and in width from 3 to 6 in. Some roads use a uniform thickness with a varying width; on others the hoop is uniform in width with a varying thickness while still others use varying widths and thicknesses and to make matters worse there is much variation in the spacing and length of sections.

There are many reasons why the standardization of tank hoops would be advantageous, chief of which is the conservation of steel; not that the standard hoop would require less steel to maintain the required fibre stress on the hoop but that it would allow the manufacturers to carry less stock to fill orders. On a recent visit to the plant of a large tank manufacturer it was found that he had on hand material to supply hoops for perhaps 30 or 40 tanks representing a dozen different hoop standards yet he could not ship two sets that were badly needed until steel was received from the mill to make up the particular type of hoop required. The standardization of tank hoops should have a tendency to lower the cost of manufacture and insure better deliveries and would, no doubt, result in a better and more uniform quality of material. It would appear that there is every reason why tank hoops should be made standard and no good reason why they should not be.

DISCUSSION

(Wooden Tanks.)

H. von Schrenk:—I don't think this report should be passed without a word of commendation on the work of the author. I think Mr. Knowles ought to be complimented on the very able and exhaustive manner in which he has dealt with the subject. I

would like to ask him if he knows of any other road than the Illinois Central which has tried creosoted material for tanks?

C. R. Knowles:—I understand the Louisville & Nashville built some a few years ago. The Big Four has built quite a number on steel towers within the last year or so. I think the Illinois Central is the first road to adopt the use of the complete creosoted structure. Our tanks are creosoted from top to bottom.

Question:—Does it affect the water for drinking purposes?

C. R. Knowles:—The creosote has no effect on the water that is noticeable except a slight taste at first, but is not absolutely harmful. The pipe line mentioned in the report as supplying water to the city of Seattle carries drinking water. The authorities had exhaustive tests made to determine the effect of the creosote and after the 18th day of the use of the pipe line there was no taste of creosote that could be detected.

Question:—What season of the year were the Illinois Central tanks erected, and if the work was done during warm weather what effect had the creosote on the eyes and faces of the men assembling the material?

C. R. Knowles:—Each man might give a different answer to that. We have erected some in the winter time which is preferable because the timber is easier handled than in warm weather, but we were erecting them all through last summer and I have heard of no objections on the part of the men engaged on the work. In fact we have been putting up creosoted towers for the past 18 or 20 years and I cannot recall any serious objections or complaint where any of the men became injured or even affected in any way by the creosote.

P. J. O'Neill:—I erected a white pine tank of 36 ft. diameter holding 125,000 gal. in 1895. After we gave it a thoro coating of carbolineum we found it had a very disastrous effect on the men and that wherever the skin was exposed it was worse than sunburn. Perhaps the men, when erecting the tub of a tank, come in closer contact with the material they handle than they do when erecting a tower. But the carbolineum certainly preserved that tank. It is as good today as ever. At the time we erected that tank we connected it with an 8 in. pipe to supply a standpipe. Later we ran a 12 in. pipe for this connection and cut another hole through the bottom of the tub. I kept the piece that was sawed out after it had been in service about 20 years and it was apparently just as sound as the day it was first put into

use. There was not the slightest indication of decay. The timber used in this tank was selected white pine and had no sap. Wherever white pine tanks have failed I think it has been due to sappy material. In later years when we used white pine for tubs I found it was difficult to get planks that one could use without losing 20 to 30 per cent on account of removing sappy material but I thought it paid even to do that. Once in a while a stave will get in which has some sap and it was found that it had to be patched before many years.

J. P. Wood:—The material which Mr. Knowles used probably had been treated with about 5 lb. of creosote per cu. ft. Had his men been using timber that had 12 to 15 lb. per ft., as is used for standard bridge work, his men probably would have made some complaints.

The Secretary:—The treatment of the material used for tanks and pipe lines is probably not so heavy as that used in bridge work and for other purposes, but even if it were it can be handled by the men without injury from the treatment if properly done and at the right time, provided the necessary precautions are taken. It is perhaps not advisable to use creosoted material or that coated with carbolineum soon after the treatment has been applied or under certain atmospheric conditions. Some degree of judgment must be applied in such cases, the same as in connection with anything else. The creosoting of material has come to stay, for some time to come at least, and we must learn how to work with it.

H. von Schrenk:—There has been a good deal of complaint from time to time as to the injuries received by workmen as a result of working with creosoted material. We have had a number of lawsuits connected with that problem and I found that the injury complained of was confined principally to light-skinned and fair-haired people. Swedes are more affected than the so-called Americans with dark skin and dark hair. In the south the negro is never influenced by it at all but a man with light skin is liable to have his hands and face blistered if he is not careful.

It was found to be the best preventive to have the foreman advise the men to cover their hands and face with a kind of oil or vaseline before they went to work; nine times out of ten they then suffer practically no effect whatever.

The degree of injury depends somewhat on the kind of treatment which is used. The creosote used years ago had a very much more active effect than that used at the present time be-

cause the oil was so much heavier. I don't think the injury usually is anywhere nearly as much as one is led to believe by some reports. I have personally traced down a great many such reports and often the injury is due to something else. It looks like a severe case of poison ivy. The application of oil is a good remedy.

E. E. Clothier:—My experience has been that my men have suffered as much on the unexposed parts of their body where the creosote seemed to penetrate their clothes as on their hands and faces, and it came to a point where they almost refused to work on account of the effects of the creosote. I never noticed the difference resulting between light and dark complected people.

C. R. Knowles:—It seems to me that some time ago a lawsuit on the Louisville & Nashville was brought by someone who claimed that he had been injured by creosoted timber and that the defense demonstrated its case by one of the parties washing his face and hands in a basin of creosote oil in the courtroom.

H. von Schrenk:—I do not know of that particular case, but I did that very thing myself and it did not harm me in the slightest degree,—although a great many people are affected by it. However, most of the lawsuits are fictitious—like the famous story of the jersey cow.

In another case two hours were spent in reading the dangers of creosote and then I was asked to agree to the correctness of the statements, to which I fully agreed. But this was a chemical compound of creosote condensed for medical purposes. That, however, has no connection with creosote oil in common use.

C. R. Knowles:—There is no question but that the most important feature in connection with the construction of non-treated wooden tanks is the selection of the material; and the premature failure of wooden tanks, I believe, can be traced almost entirely to the poor selection of material where a durable long-lifed timber has been used. I recall an incident of a few years ago where we moved three cypress tanks. Our standard up to within the last 10 years was an 18 ft. by 30 ft. tank. We moved three of these, one of which was constructed in 1904, another in 1909, and the third in 1911. The first of these was in better condition than either of the other two, and I think that we renewed three staves in it when we rebuilt it. We renewed something like 14 staves on one of the other tanks and 20 to 30 on the third. These were reconstructed after being in service from 6 to 10 years and were

better then than before on account of culling out the poor material that crept in in the first place.

W. E. Alexander:—I am interested in this talk on wooden tanks. We are in a cold climate and have nothing except wooden tanks on our road (the Bangor & Aroostook). We have tanks ranging in size from 10,000 gal. to 100,000 gal. capacity. We have some tanks that were built as far back as 1892 and some of them are still in service. They were furnished by Fairbanks, Morse & Co., and were built of Michigan pine. They have the original hoops, but some of the later tanks have hoops that last but a short time. We had one tank which was erected on a 50 ft. tower where the hoops rusted off and fell to the ground twice in three years. Where the modern hoops are likely to give out we place round hoops between the flat ones as a matter of safety.

In our country one cannot build tanks that are secure from frost. We usually enclose the space beneath the tank and provide a stove with a cast iron pipe extending up through the tank which prevents freezing. Some of the tanks are provided with oil heaters. We tried tanks built in the ordinary way with the standard frostproof boxes but we had to resort to the heaters. It is a serious problem with us when the temperature gets from 35 to 40 deg., and more, below zero, especially where we do not pump from wells and where we do not use a great deal of water. Wherever we have steam pumps we also run the exhaust steam into the water going into the tank which helps a great deal.

We have never lost a tank from heating by stoves and oil heaters.

J. P. Wood:—Where a tank is emptied once in 24 hr., even in our cold climate in Michigan, it does not require any extra precautions beyond the standard frost-proofing, except that one should see to it that water is properly drained in the vicinity of the frost box. This year I have been equipping frost boxes and stand pipe pits with a steam coil direct from the pump boiler. Of course, where we have only gasoline or kerosene engines we are not able to do that.

I have one plant where the piping is protected with asbestos covering. We have yet to ascertain just what success we will have with that. It has been in service a couple of years and so far we have had no trouble. Just now we are using a frost box with two air chambers just large enough to contain the pipe

and the pipe covering. The frost box is only about 12 in. in diameter over all.

P. J. O'Neill:—We have a great many wooden tanks but I have no fear from frost. Last winter when it got down from 10 to 20 deg. below zero we experienced no frost trouble. I do not mind the freezing of the ice on the inside of the staves. Let it freeze; it is a protection after it becomes 15 to 18 in. thick. We put a 12 in. extension on the outlets in the bottom of the tanks to allow for freezing.

We construct a brick frostproof box just inside of the four center posts, built of two brick walls with a 4 in. space between. We have a concrete pit in the bottom in which a fire may be built if the temperature gets below zero. There is no danger, for the fire is 25 to 30 ft. below the bottom of the tank. That keeps the frost box warm all the way up. The bricks get warm and I dare say that 24 hr. to a week after it will not freeze in that frost box.

C. R. Knowles:—Two air spaces are not enough in this climate where building paper and lumber is used for the frost box. Brick is much better. In addition to being a better frost protection it is also fireproof. Where we use lumber we make four air spaces on the northern territory occupied by our road. That part of the frost box beneath the ground is built of concrete with a 12 in. wall. The central air space extends below the frost line and there is no trouble with freezing of the inlet pipes because of the benefit of the warmth from the earth below. It gets pretty cold in Iowa and Minnesota. The winter of 1911 and 1912 I don't believe it was warmer than 20 deg. below zero at any time from the middle of January to the middle of February, but we had very little trouble with outlet pipes freezing. I think a great deal of the trouble, where it exists, results through carelessness in allowing the outlet valve to leak, but where it is kept tight and where the tank is filled and emptied daily there should be little or no trouble in this latitude with wooden tanks. We use stoves in a good many of our tanks west of here but they are mostly on branch lines where we have but one or two trains per day and a tank of water may last perhaps a week. However, I really think that the majority of the stoves are used largely as a force of habit.

E. E. Clothier:—We (C. M. & St. P.) have four air spaces in the frost box. The inner space is large enough to accommodate a car heater. The temperature in our country west of Mobridge

gets as low as 42 deg. below. I have had tank valves become clogged with ice when the water would escape in sufficient quantity to freeze the train to the track opposite the tank. At each tank we have a hose that can be connected with the locomotive to be used in thawing ice in and about tanks.

C. R. Knowles:—It is true that trouble is often caused in tanks from ice breaking loose during thawing weather, getting under the valves, etc. Then again, while an engine is taking water ice may form in needles and sometimes freeze the valve to the seat.

F. M. Case:—I would like to ask Mr. Knowles as to the thickness of the staves and bottom of the Illinois Central tanks?

C. R. Knowles:—Our tubs are built of 3 in. material throughout.

F. M. Case:—Some roads use 4 in. material. What is your opinion of the difference in the lasting qualities of the 3 in. and 4 in. material?

C. R. Knowles:—I cannot say, but I think the same theory would apply as with the wood stave pipe lines. If you exceed a thickness of 3 in. in tank material you are going beyond the limit of saturation; in other words the inner portion is saturated and the outside shell is dry, which promotes decay. Therefore I should think a 3 in. thickness is preferable.

A. S. Markley:—We do not use stoves and as a result we have some freeze-ups. There is a difference where the water is supplied to a locomotive from a tank or from a stand pipe. One is liable to have trouble in taking water direct from a tank if a leaky valve exists. We have pine tanks in service since 1888 which are in good condition yet. We have red cypress tanks built in 1881 which are still good. We have fir tanks that were built in 1884 one or two of which have been renewed while we will have to renew several more in the next few years.

P. J. O'Neill:—Our water tanks are tapered. I do not like a tank with parallel staves. With the latter if the tank shrinks a little the hoop will fall, while on a tapering tank it simply drops down a little and tightens itself.

J. P. Wood:—I am becoming disgusted with steel hoops as I presume every other man is who has had experience with them. Hoops that were put on tanks 30 or 40 years ago, made of wrought iron, are still good, while the average life we get out of the modern steel hoop is from 6 to 10 years.

BRIDGE DECKS AND GUARDS

COMMITTEE REPORT

The committee received replies from 25 railroads in response to a circular letter sent out soliciting prints of standard practice with reference to bridge decks, ties and their spacing, inner and outer guard rails, etc. All but 7 responded to the inquiry for information wanted although some of the roads sent only partial data as to bridge decks.

A tabulation for open floor decks for typical steel bridge spans has been compiled in Plate 1 from the various replies received, which it is hoped will be of interest as showing current practice among most of the larger railroads. The committee was impressed with the practical agreement as to the use of T-rails for inner guards. Generally second hand and scrap rails removed from running tracks or from stock are used. An old frog point, or a point casting, is used where facing the traffic and in a few cases also where trailing the traffic. Plate 2 illustrates the use of the inner guard of T-rail section in connection with a second-hand or remodeled frog point. Plate 3 shows a type of point casting used by some of the railroads. Points are of course used at each end of a single track bridge, the distance from bridge ends varying from 30 ft. to 90 ft. The distance between the heads of running rails and guard rails is found to vary between 8 and 10 in. However, 8 in. and 9 in. spacings predominate. It is not clear in some cases whether the inner guard rail is spiked to every tie or every other tie. Plate 2 shows the inner guard rail spiked to every other tie throughout the length of the bridge. Plate 4 shows the Pennsylvania railroad standards for bridge guards.

The decks of timber bridges need not be fully discussed in this report as they have been covered previously in volume 25, page 71 of our proceedings. It is noted however in the replies received that 8 in. by 8 in. ties, 10 to 12 ft. long seem to be the most popular for decks of timber trestles, with 6 in. by 8 in. outer guard timbers generally in use.

The fire proofing of bridge decks has been also reported on in volume 21, page 47. There is apparently no change in this practice. Bridge number boards are generally attached to the bridge decks and our members are referred to volume 21, page 85 for a committee report on this practice. Also for the kinds of timber entering into timber trestles and in bridge decks one should refer to volume 19, page 175 of our proceedings.

Plate 5 shows the practice of the Rock Island lines with respect to ballasted floors for steel girder spans. A treated timber deck supports the ballast and track. We consider this good practice where treated timber is used in preference to reinforced concrete deck slabs. The matter of reinforced concrete decks in connection with ballast floors is a subject in itself and one should refer to volume 24, page 133 of our proceedings for a concise report on this practice.

Referring to the subject of the open floors in steel bridges, the general practice seems to be as follows: Every second or third tie is bolted to steel stringers or girders. Outer guard rails are generally bolted to every third or fourth tie by means of machine bolts or lag screws. Inner guard rails are usually spiked to every second tie, and in a number of cases to every tie.

The tabulation on Plate 1 shows the practice with reference to spacing ties and guard rails. Most of the replies received did not indicate whether tie plates were used under running rails on ties on bridges. We assume that railroads using tie plates under rails on ordinary ballasted tracks on roadway would likewise use them on

bridges. It is hoped that the use of tie plates will be fully brought out in the discussion of this report. One company reports the use of tie plates also under the inner guard rail.

It is suggested that railroads working up new standards of practice should be governed by the following principles, so far as steel spans are concerned: A constant distance should be maintained from center to center of stringers, and of girders up to considerable span length; no change in size of tie will then be found necessary. The width of deck and the distance "in to in" of outer guard rails may thus be kept uniform, which will give a good appearance, and also reduce the number of sizes of sheets of galvanized iron required to be held in stock where it is the practice to fireproof decks with sheet iron.

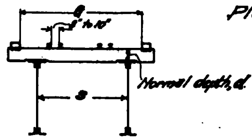
H. A. Gerst,
W. S. Bouton,
J. S. Huntoon,
W. A. Spell,
E. K. Barrett,
F. A. Benz,
W. L. Rohbock,
R. H. Reid,

Committee.

AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION.

Subject: Bridge Decks and Guards.

Plate 1.



For methods of taking care of Superelevation of rails, see Vol. 20, p. 99.

TYPICAL CROSS SECTION.

DIGEST OF CURRENT PRACTICE FOR OPEN FLOORS ON STEEL BRIDGES.

NAME OF RAILROAD	GENERAL DETAILS OF DECK.						GUARD RAILS		REMARKS
	SIZE OF TIE	d inches	S ft-in.	g ft-in.	SPACING OF TIES inches	TIE PLATES USED	INNER, KIND	OUTER; SIZE	
A.T. & S.F.	8"x8"-12'	7½	7-0	7-7	12	[illegible] Yes	T-rail	6"x8"	Same size tie for several types of stgrs.
B. & O.	8x8-9 Larger ties	7½ —	6-6 Var.	6-10½ —	14		T-rail	6x8	Main rail spiked every other tie, except on curves spiked every tie.
B. R. & P.	8x12-12	11½	8-0	10-8	14	Each tie, Main Lines	T-rail	6x8	8"x10"-10' Ties used for spans less than 75'
"	8x10-10	9½	7-0	8-8	14		T-rail	6x8	See above.
C. & O.	8x10-10	9½	6-6	8-0	12		T-rail	7x8	Inner gd. rail on all bridges
"	8x12-11	11½	8-0	9-0	12		T-rail	7x8	ditto
C. & N.W.	8x8-12	8	6-6	10-4	12	Generally on Curves		*10x12	*Bolted every tie
"	8x10-12	10	8-0	10-4	12	"		*10x12	" " "
C. B. & Q.	8x10-10	10	7-0				T-rail	6x8	
"	8x12-10	12	8-0				T-rail	6x8	
C. M. & St. P.	8x12-10	11¾	7-6	Var.	12		4"x8" Timber & 6x4x½ L.	5x8	Spacing blocks used between ties
"	8x12-12	11¾	8-0	"	12		4x8 Timber & 6x4x½ L.	5x8	ditto
C. R. I. & P.	8x10-10	9½	7-0	8-7	12		T-rail	6x8	Main rails full spiked over entire bridge.
"	8x12-12	11½	8-0	10-0	12		T-rail	6x8	ditto
ERIE	8x8-9	7½	5-0	7-6	14			5x8	Mach. bolts every 3rd tie in outer G.R.
"	8x12-10	11½	8-0	7-6	14			5x8	Lag screws " " " " " "
FLOR. E. COAST	8x10-10		7-6	7-0	16		T-rail	6x8	ditto
"	10x10-11		7-9	7-0	16		T-rail	6x8*	*4"x4" tie spacing blocks used.
GR. TRUNK	10x10-13	9½	7-0	11-6	14		T-rail	8x8 ←	For Branch Lines, 8"x8"-12' ties are used
GT. NORTHERN	8x12-12	11¼	7-6	10-0	12	Each tie, Main Lines.	T-rail	6x8	No tie pls. and rails spiked every other tie, on Br. Lines, except as otherwise ordered.
ILL. CENTRAL	8x8-10	8	7-0	7-6	14		T-rail	6x8	
"	8x10-12	10	8-0	8-4	14		T-rail	6x8	
L. & N.	8x8-10	8	6-6	6-10	14		4"x9" Timber*	5x9	G.R. Fastened with lag screws. *T-rail also used. Tie plated on curves.
"	8x11-13	10½	9-0	6-10	14		4"x9" Timber*	5x9	ditto
MICH. CENT.	8x10-12	7	6-6	10-8				6x8	Ties laid flat. Data from special plan.
N.Y. CENT.	8x10-11	Var.	6-6	9-8	12		T-rail	5x8	
"	8x12-11	"	8-0	9-8	12		T-rail	6x8	
N.Y. N.H. & H.	8x8-11	7½	6-6	7-0	14		T-rail	6x8" Timber & 3x2½ L.	
"	8x12-11	11½	8-0	7-0	14		T-rail	6x8 Timber & 3x2½ L.	
PENN. LINES W.	8x8-9		6-6	7 alt.	14		T-rail	6x8	Inner gd. rail braces every 3rd tie.
PENNSYLVANIA	10x9-9	9	6-6	6-10 alt.	16	Each tie.	T-rail	6x8	10"x10½"-11' ties used where S=8'0"
UNION PACIFIC	8x10-10	9½	7-0	7-0	12	" "	T-rail	5x8	
"	8x12-12	11½	8-0	7-0	12	" "	T-rail	5x8	Also larger ties for wider stgr. spacing
W. & L.E.	8x12-10	11½	7-6	Var.	14		T-rail	6x8	

Note: 21 Railroads use no tie spacing blocks, but dap outer G.R. from 1" to 1½" - 3 companies use tie spacing blocks.

Plate 1

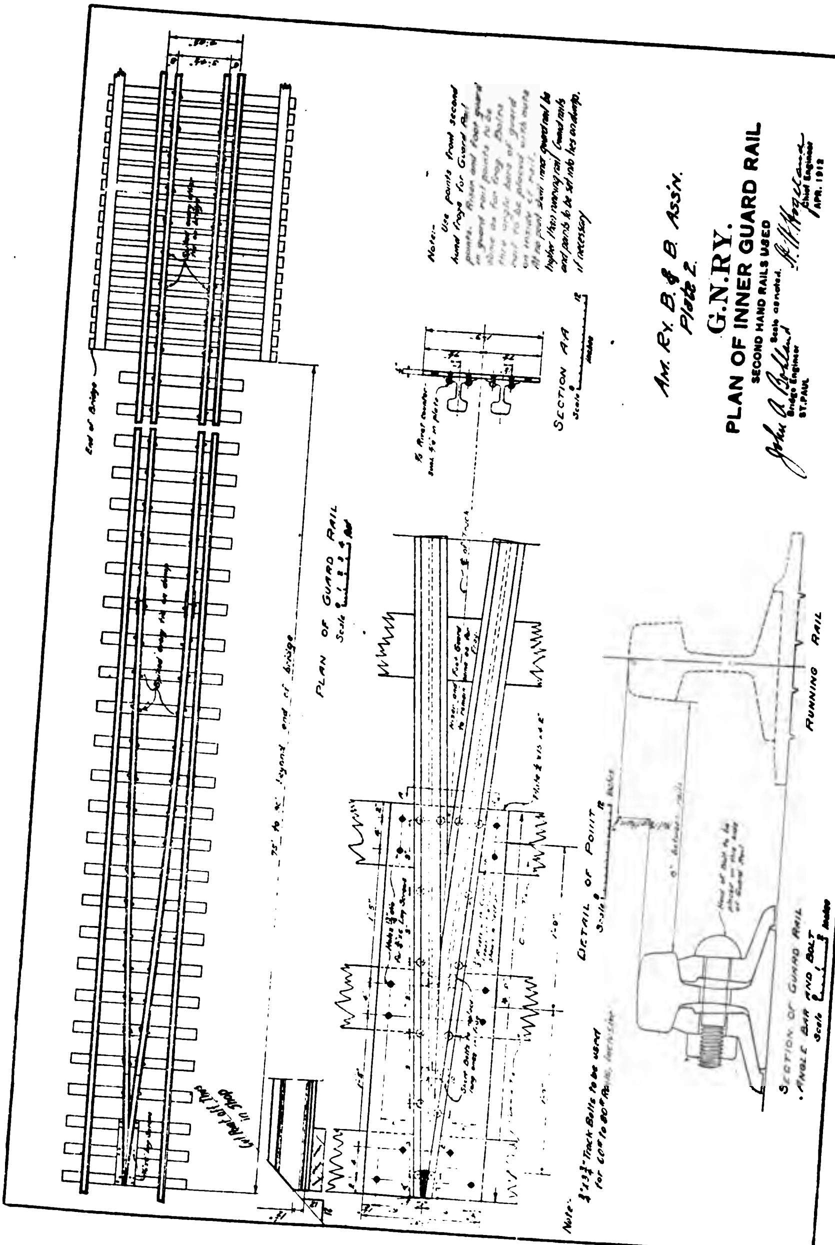


Plate 2. Inner Guard Rail, Great Northern Ry.

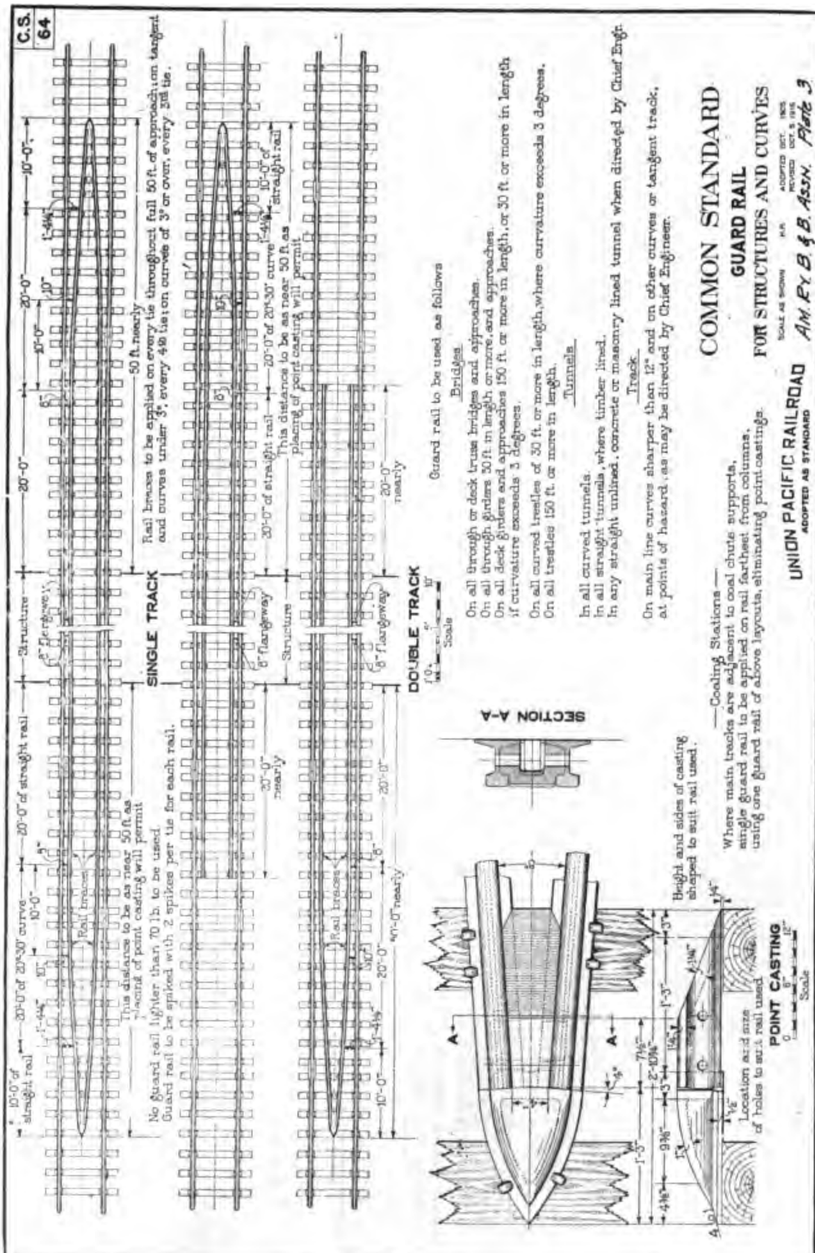


Plate 3. Standard Guard Rail, Union Pacific R. R.

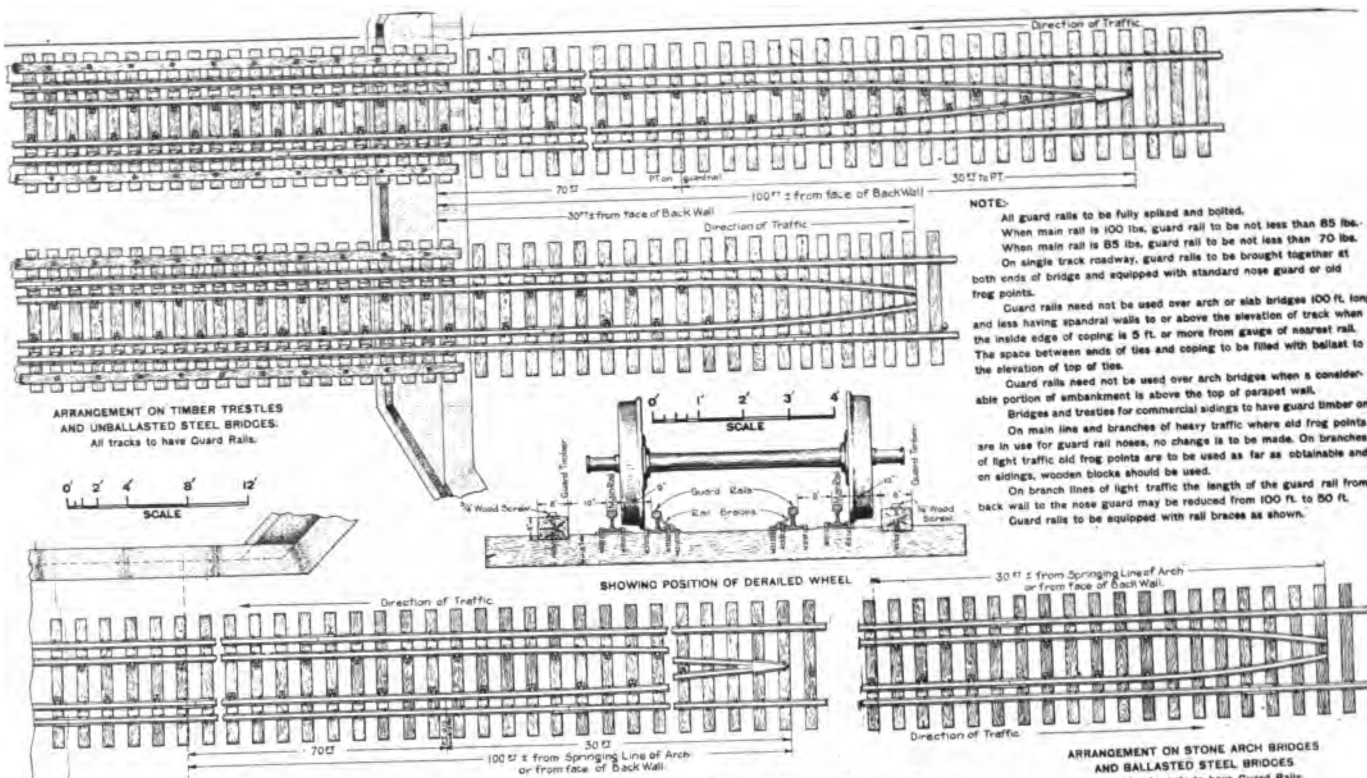


Plate 4. Standard Bridge Guard, Pennsylvania R. R.

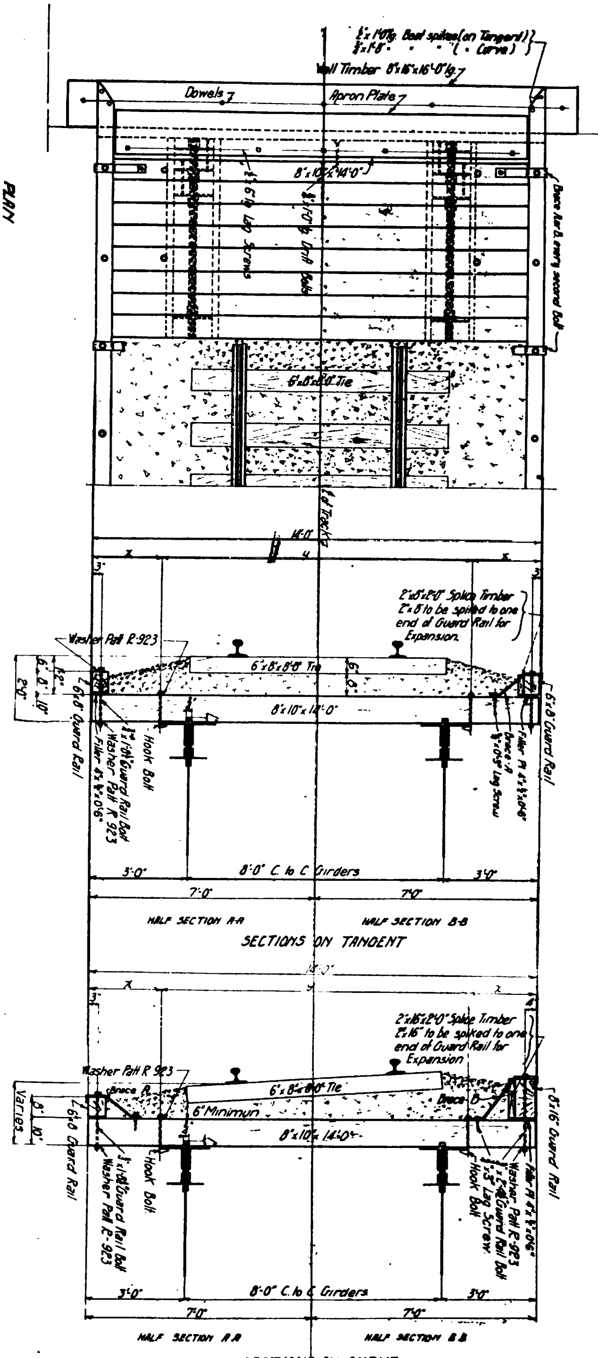


Plate 5. Bridge Decks and Guards, C. R. I. & P. Ry.

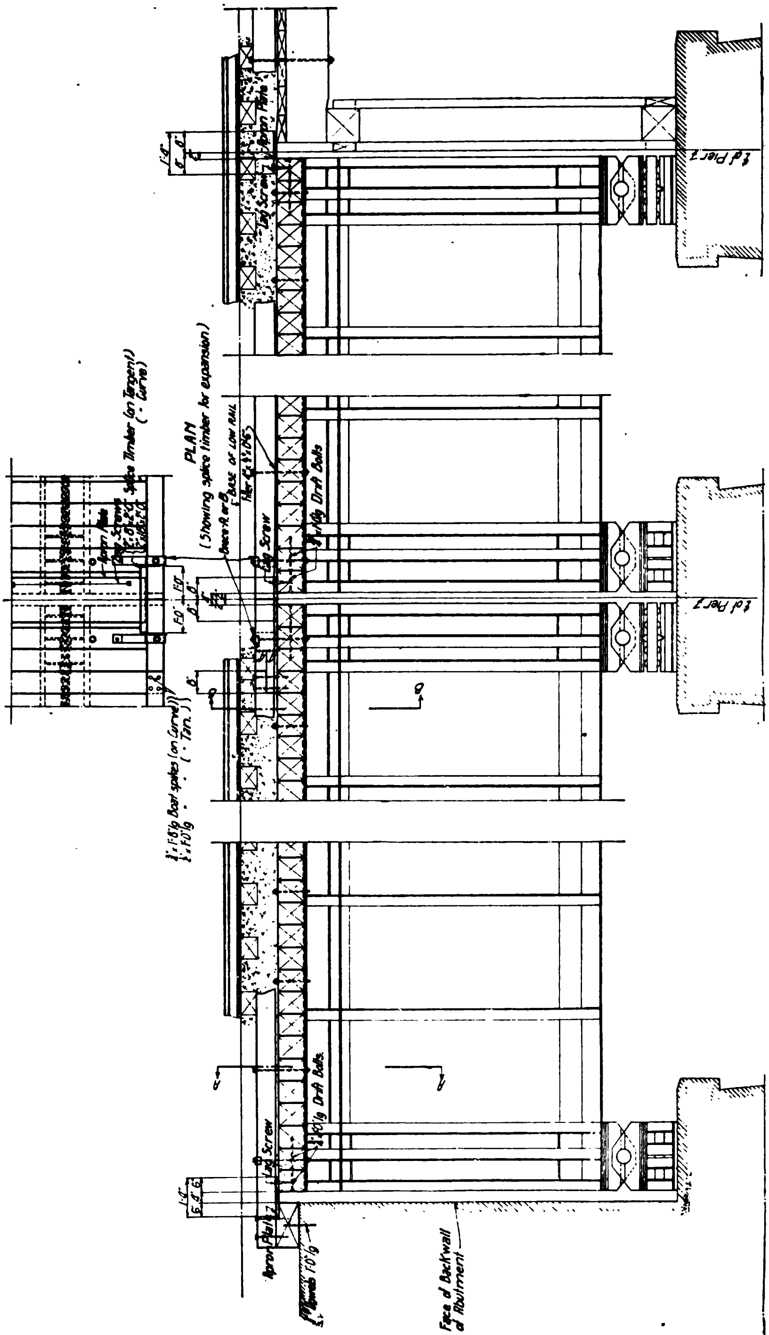
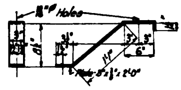
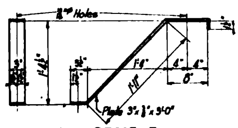


Plate 5a. Bridge Decks and Guards, C. R. I. & P. Ry.



GUARD RAIL BRACE -A-.
Weight each: 7# lbs.
Brace A to be used on both guard rails, when track on tangent and on inside guard rail only, when track on curve.



GUARD RAIL BRACE -B-
Weight each = 11.6 lbs
Brace B to be used on outside guard rail only, when track on curve.

Note:-
Braces to be spaced, every second guard rail bolt.

General Notes:-
All timber to be creosoted.
Guard rails and Floor ties to be bolted in second tie from the ends of Girders. Intermediates to be bolted at intervals not exceeding four (4) ties.
Drift bolt end tie to second tie and second tie to third tie, with ¾" drift bolts 1'-0" lg. drifted in ⅝" holes.
All holes for bolts to be bored of such diameter as will allow a driving fit.
All timbers which are to be treated shall be framed before treatment.
Holes bored in treated timber shall be filled with heavy coal tar creosote before bolts are put in place. Unused holes must be filled with creosoted plugs.
Whenever cutting is necessary the new surfaces shall be coated with heavy coal tar creosote, the creosote to be heated to a liquid condition and applied while hot.

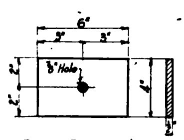
Hook Bolts Holes in Floor Ties.		
Length of Span	x	y
50'-0"	2'-5½"	9'-1½"
55'-0"		
60'-0"	2'-3½"	9'-5½"
65'-0"		
70'-0"		
75'-0"		
80'-0"		
85'-0"		
90'-0"	2'-2½"	9'-7"
95'-0"		
100'-0"		
105'-0"		
110'-0"		

C. R. I. & P. Ry.

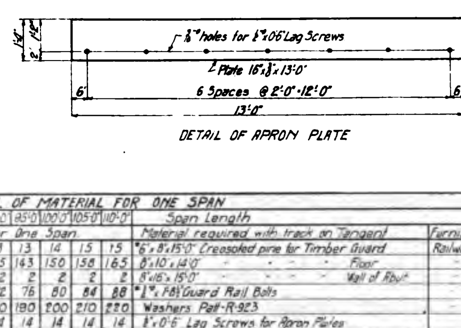
BALLAST FLOOR PLAN
FOR
DECK PLATE GIRDER SPANS
50'-0" TO 110'-0"

SCALE 1"&1"=1'0"
ADOPTED Nov. 4-1913

APPROVED [signature] Chief Engineer
APPROVED [signature] Second Vice President



FILLER PLATE WR'T. IRON
Weight = 3.4 lbs



DETAIL OF APRON PLATE

BILL OF MATERIAL FOR ONE SPAN														
50'-0"	55'-0"	60'-0"	65'-0"	70'-0"	75'-0"	80'-0"	85'-0"	90'-0"	95'-0"	100'-0"	105'-0"	110'-0"	Span Length	
Number required for One Span													Material required with track on Tangent	Furnished by
7	8	9	9	10	11	11	12	13	13	14	15	15	*6"x8"x15'0" Creosoted pine for Timber Guard	Railway Co.
75	83	91	98	105	113	120	128	135	143	150	158	165	8"x10"x14'0" " " " " Floor	" "
2	2	2	2	2	2	2	2	2	2	2	2	2	8"x16"x15'0" " " " " Wall of Abut	" "
40	44	48	52	56	60	64	68	72	76	80	84	88	*¾"x1'-8½" Guard Rail Bolts	" "
100	110	120	130	140	160	160	170	180	180	200	210	220	Washers Patt-R-923	" "
14	14	14	14	14	14	14	14	14	14	14	14	14	¾"x0'-6" Lag Screws for Apron Plates	" "
12	12	12	12	12	12	12	12	12	12	12	12	12	¾"x1'-0" Drift Bolts	" "
24	24	32	40	40	48	48	48	56	56	56	64	64	*½"x1'-0" Boat Spikes	" "
10	10	10	10	10	10	10	10	10	10	10	10	10	1"x1'-0" Dowels	"
40	44	48	52	56	60	64	68	72	76	80	84	88	Hook Bolts	Bridge Co.
2	2	2	2	2	2	2	2	2	2	2	2	2	16"x½"x13'-0" Apron Plate-Additional span reqd 1 Plate per span.	" "
													*2"x8"x2'0" Splice Timber (creosoted) Add span reqd 2 Pcs per span	Railway Co
20	22	24	26	28	30	32	34	36	38	40	42	44	*Brace A (see detail)	" "
40	44	48	52	56	60	64	68	72	76	80	84	88	Filler Plates " "	" "
20	22	24	26	28	30	32	34	36	38	40	42	44	¾"x0'-3" Lag Screws for Braces.	" "
24	26	28	30	32	35	37	39	42	44	46	48	51	Cu yds of Ballast 0.46 cu yds per lin ft	" "
For track on curve use half the number of pieces marked * and add the following.														
4	4	5	5	5	6	6	6	7	7	7	8	8	8"x16"x15'0" Creosote pine for Timber Guard	Railway Co
													2"x16"x2'0" Splice Timber (creosoted) Add span reqd 1 Pc. per span	
20	22	24	26	28	30	32	34	36	38	40	42	44	¾"x2'-4½" Guard Rail Bolts	" "
12	12	16	20	20	24	24	24	28	28	28	32	32	½"x1'-8" Boat spikes	" "
10	11	12	13	14	15	16	17	18	19	20	21	22	Brace "B" (see detail)	

Plate 5b. Bridge Decks and Guards, C. R. I. & P. Ry.

DISCUSSION

(Bridge Floors and Guards)

H. A. Gerst:—I would like to ask if any of the members present have any thoughts on the matter of spiking the rails to bridge ties where the angle bars occur. There seems to be a difference of practice in that respect and I believe the discussion ought to touch on that particular point.

F. E. Schall:—On the Lehigh Valley we do not spike the rail through the slot in the angle bars on bridges, on account of the creeping of the rails. This is especially objectionable on through bridges where the floor beams project above the base of the rail. The spiking of angle bar slots invariably splits the tie so spiked.

D. B. Taylor:—The B. & O. does not spike in the slots of the angle bars on account of the creeping of the rails, just as explained by Mr. Schall.

H. A. Gerst:—I would like to ask if any of the members know of the practice of spiking over the lip of the angle bar through holes especially punched in the tie plate? That is, not spiking through the slots in the base of the angle bar but on the outside of the lip so that it will not prevent the rail from creeping?

E. E. Clothier:—I do not think it is practical to spike through special slots or at the ends of the angle bars.

H. A. Gerst:—I meant through special holes in the tie plates, so that the spikes could be set out.

E. E. Clothier:—We spike through the tie plates. We always keep away from the angle bars. We do not spike at the ends of the angle bars or through the bars.

H. A. Gerst:—Or along the side of the bar?

E. E. Clothier:—Along the bar the spike allows the rail to creep with the change in temperature but does not move the tie.

H. A. Gerst:—But you do spike along the side of the angle bar?

E. E. Clothier:—Yes, but not in the slots or the specially provided holes.

A. McNab:—We space our ties 12-in. centers and spike every other tie. We never allow the bridge men to spike the angle bars but when the section men come along, if anything occurs they will spike them. How are you going to get away from that condition? That has been the great difficulty and we find that we

have more or less trouble right along with the section men spiking the slots in the angle bars on bridges.

W. E. Alexander:—I agree with what has been said about not spiking in the slots or at the ends of the plates and of the angle bars. It is poor practice. It is liable to injure the tie. The rail will creep some and if it creeps the spike will injure the tie where it is fastened here and there. It is only at the joints that that happens but it is liable to injure the tie there. I have seen it done frequently. Our practice is to put hard pine ties on bridges on 12-in. centers, spiking every tie and boring for the spiking. We never spike without boring, as it injures the ties. We have spiked some ties without boring them and the result has been that whether they split then or not, they will split eventually, for the strain on the wood with the action of the weather will split them.

You have heard me speak before about the three guard rails between the running rails. I advocate that yet. The three rails between the running rails will save the ties in case of a wreck where the trucks may be thrown cornerwise. No truck can strike a tie to injure it with three rails between the running rails. You cannot put a truck on there that will tear the ties up but you can tear a whole bridge floor out with two guard rails and none in the center. I have seen that done. It can never occur with the center guard rail. You see some bridges here and there that have the center guard rail; the Canadian Pacific uses it on nearly all of its bridges. We have it in some of our bridges. I wish we had it on all of them because I have seen the beneficial results.

Another thing I do not approve of,—is the general practice of bringing the rails to a point. I prefer the guard rails to go straight down at the end of the bridge or wherever the guards come. I know of a case where we had a wreck due to a pointed guard rail. I am satisfied we would have had no wreck if there had been no pointed guard rail there. The derailment occurred on a curve and the truck worked over the ends of the ties until it was past the point of the guard rail which threw it the wrong way. If there had been a center guard rail, or if only the two guard rails had been there and they had not ended at a point, the truck certainly would have caught it inside of that guard rail and if it had it would have landed on the bridge ties because the ties were long enough to carry it. As it was, it was thrown clear over and we had quite a wreck. There are times when the ground is frozen and the road is icy, that a point may guide the wheels over properly but when

the ground is soft I think there is no place where that point will ever bring the truck in. It will go right over; at least that has been my experience.

J. S. Huntoon:—I approve what has been said about slots. We have had some very disastrous results. I would like to ask some of these gentlemen what they do on drawbridges where rails creep and run and have to be held secure in some instances—where slot spiking has been resorted to and there have been no serious results? We have had trouble putting on the regular track creepers because they are not effective.

A. H. King:—I would say that on a drawbridge the creeping would hardly be noticeable. Disconnect the two ends and it would hardly be worth figuring. As regards the inside guard rail which has been spoken of by Mr. Alexander, there is no question but that the dipped rail at the end that he recommends is preferable to the point. I can see very readily where a derailment might strike squarely on a point and cause a wreck, possibly throw a car crosswise of the track. I think that all we can expect of a guard rail is to skid the derailed truck over the bridge; beyond that if we try to derail it I believe we will miss our calculation every time.

As far as the spiking in the slot is concerned, that is something that we tried to avoid the first year that I was engaged in bridge work. An absolutely free movement of the rail across the bridge is what we always tried to get and we tried to avoid anything that would restrict that.

R. H. Reid:—In regard to the anchoring of rails on drawbridges, we have used a special rail anchor on the New York Central. It is bolted to the rail and bolted to the ties on each side of the floor beams. The ties set close up against the floor beams and they cannot move either way. This is a positive anchor, bolted through the web of the rail and has prevented any movement of the rail on the draw span.

If the approaches are on girders or stringers where floor beams are not available, we bolt an anchor to the top flange of the girder and bolt them the width of the tie apart so that the ties, or as many as may be necessary, fit in on top of the girder between those anchors and the ties cannot move. They are positive and they hold the ties in place.

In regard to the spiking of ties in slots on bridges, I did not suppose there was any question about that. I supposed that it had been generally recognized that it was not advisable to spike

the ties in slots on any bridges. If the rail creeps, the spiking in the slots will tear and destroy the ties. If the rail does not creep it is not necessary. We have had an abundant experience where ties have been simply destroyed—the rail will keep on creeping and the tie plates will shove the spikes ahead of them and split the ties and finally will tear them out. It is the same way if you have tie plates on ties ahead of rail splices where you have splices that will catch the plates. Those splices will go ahead and foul the tie plates and if they keep on going, as they will with the creeping of the rail, they will destroy the ties all to pieces. If the rail must be anchored on bridges, it should be anchored with special anchors next to the ties which are against the floor beams so as to prevent the destruction of the ties.

H. A. Gerst:—I believe most of us are agreed that the rail should not be spiked through the slots in the angle bars, but it has been done and perhaps this discussion will bring out the fact that it should not be done.

W. M. Camp:—Slot-spiking has long been recognized to be a very dangerous practice. Not only does the spike split the ties but creeping rails have carried not only ties but bridge girders off their seats.

It has long been a question whether bringing guard rails to a point in the center of the track is a measure of safety or one of danger. If the derailed truck is running close to the rails then the guard rails brought to center may guide it back toward the proper position. However, if the truck is derailed more than half the gage of the track, it will catch beyond the point and it will usually cause a pile-up at the end of the bridge. For that reason the practice of using three guard rails in a straight line, one at a distance of eight or ten inches from each of the running rails and the other in the middle of the track has been adopted on some roads so that when a derailed truck comes along the idea is that the safest thing to do is to leave it alone. The middle guard rail is just simply a precaution.

I think the place to anchor drawbridges is along the bank. If there is a long trestle approaching the bridge, it pays to anchor the bridge along the bank. A trestle is a very insecure place to anchor rails to. As traffic gets heavier, the tendency of rails is to creep and that tendency is greater today than it ever was before. More double track exists and traffic is heavier, so the question of creeping rails is more important today than it ever was

before and the various devices for anchoring rails are also important. Some even go so far as to put down concrete piers with very heavy anchors. Others take pains that the approaches to bridges shall have extra anchors on the rails for a distance of 1,000 ft. or more in order that there may be security against creeping rails at the bridges even if at points on the road where there are no bridges the tracks are allowed to creep a little.

R. C. Henderson:—The Baltimore & Ohio standard practice is to use a special tie plate. I find that my trouble is to get anything for a bottom plate. There ought to be a plate put under the angle bar. I have picked up half inch iron (or whatever it takes) and slipped it under there and spiked it so it will not work out. We have to use a common spike on the angle bar and spike the rail on the side.

With reference to guard rails we do not use any special point but bend the rail down between the ties at the approach to the bridge, bringing it in to about 6-in. centers. Lately we have been bringing these rails in to about 12-in. centers.

A. McNab:—With regard to drawbridges, we have one at St. Joseph, Mich., with a 200-ft span that gives me more trouble and work than the rest of the line. There is 700 ft. of trestle at the north end. We have tried to do everything we possibly can to keep that drawbridge in operation but every once in a while we have trouble and I do not see how we can prevent it.

W. M. Camp:—There is something similar to that in the tunnel at St. Louis approaching the Eads bridge. They use switch points on the Eads bridge letting the rails run and the switch points adjusting it. When the switch points creep too far they cut out a section of track behind them and pull it back again. That is the only way I have ever seen that problem solved—to use switch points, let the track run and then take it up once in a while on the bridge.

R. H. Reid:—As I understand Mr. McNab, he is asking in regard to the expansion of the rails or of the bridge due to the sun. We have a draw span of 310 ft., where we have to take that factor into account. If the bridge stands long in one position one side will expand so that when we close it it won't close up well and every time we open that bridge we reverse it. It stands in the sun until it is opened for a boat and when we close it we reverse it and put the other side in the sun for a while and if it is not called for often enough by boats we open the bridge and re-

verse it anyway so as to keep the expansion reasonably equal. It is a bridge that works either end to.

In case of a long span which will not reverse, of course that procedure may not be practical but even in a case of that kind if the traffic is not too heavy the draw span can be opened and partially reversed enough to get the effect of the sun on the other side for a while and when it is necessary to close it for traffic it can be swung around and closed without much trouble.

A. McNab:—That is exactly the position we are in. We have got to keep turning the bridge around in the sun occasionally or else in the summer time it is hard to operate.

The President:—No doubt the sun has a considerable effect on the bridge in that way.

SHIPPING COMPANY MATERIAL ECONOMICALLY

REPORT OF COMMITTEE

The subject assigned to this committee is that of shipping company material economically or securing the greatest possible use of the least possible number of cars for this service. The Government has placed orders for 100,000 cars but we need at least 150,000 cars for replacements alone this year. The cars on order will add only 4.3 per cent to our car equipment while the wear and tear of ordinary service depletes our supply 4 per cent. To help meet this condition every one of us must endeavor to contrive the quickest and most economical way to handle our material, and release cars with quicker dispatch and with the lease possible labor.

The first thing to be considered is loading properly and to car capacity. In this the user must keep in close touch with his storekeeper. On our road, we run what is known as a supply train over each division monthly, starting this train from the east end of the division and working west. This train has a regular scheduled time to run and all parties in need of supplies must have their orders in at least six days before the train leaves the main division storehouse, on its trip. Light supplies are loaded in box cars and heavy supplies in gondolas in order that they can be unloaded by air unloaders as shown in the photograph. This unloader is double-ended and two cars can be

Double Air Hoist for Handling Material, B. & O. R. R.

unloaded at same time with a small force of men. This supply train gathers up surplus materials and scrap along the line at the same time and in the same manner as it unloads it. We find this method economical and successful. In shipping material in car-load lots it is frequently necessary to load supplies for several different points in order to secure capacity loading. In such instances the material for points farthest away should be loaded first so that the first stop has its material on top and so on. This applies to one division. Where there is a quantity of light material for various points on different divisions car loads of this kind of material can be handled by loading the cars to a transfer point where the lading is transferred to cars which can be

loaded to capacity for that point direct. This will result in conserving cars. In handling our supply trains all parties interested in receiving materials are advised of the day of their arrival and as nearly as possible the time so that they will be on hand to receive and help to unload their supplies it thereby avoiding delays.

Single Air Hoist for Handling Material, B. & O. R. R.

In handling bridge materials which are not too heavy a single-end air unloader is a very valuable and necessary help. Such a device can be built on a flat car with a 10 in. cylinder and an 8 ft. lift, although this can be lengthened to 10 ft. with a capacity of at least 3,000 lb. as shown in the photograph. These unloaders can be built very economically and cost about $1,000 in addition to an old flat car properly strengthened. Each master carpenter could have one on his division. With heavy bridge material such as girders, etc., a heavy locomotive crane would necessarily have to be used.

To insure safety and promptness in handling materials and the quick release of cars there must be harmonious coöperation on the part of all concerned. Also if the division car service man would send a statement each month to each party on his division responsible for the prompt release of cars, showing the time cars were received for unloading and the time released and returned and classified in order as to standing in promptness in releasing cars an incentive would be created that would result in much good to car service. In my planning of my work I classify it under the following heads: (1) emergency. (2) urgent. (3) routine. By emergency I include that which demands immediate attention and supersedes all other work. Urgent work is that by which the greatest good to the service can be obtained through the releasing of cars. Routine work is that which follows in its turn accordingly as orders are received.

Let us summarize the leading points considered: (1) Load to car capacity. (2) Load properly to enable cars to be released quickly when several points have material in the same car. (3) Give prompt notification to parties to whom contents are consigned. (4) Provide mechanical air lifts to aid in unloading in order to reduce man power. (5) Create an

appreciation of the demand for car service owing to the war. (6) Arrange for the division car service man to keep a record and notify all concerned as to their standing in the prompt release of cars. (7) Impress all concerned of the urgent need of the most hearty and harmonious cooperation.

Z. T. Brantner,
E. C. Zinsmeister,
G. T. Richards,
A. H. King,

Committee.

DISCUSSION

(Shipping Company Material Economically.)

L. D. Hadwen:—One point the paper does not touch on is that of saving cars. The matter of cooperation with the operating department is very important. It is also important that the material be loaded so it can be recognized readily at its destination and when the load in a car is destined to several points it can be gotten at readily in the order of the stations at which the car is set out.

E. T. Howson:—I think I referred in this convention last year to a remark made by the vice president of one of the largest roads to the effect that when he started this campaign he received a much more ready response from the shippers than from the company men. That has been the experience of other roads. Company men have been used to having cars shipped whenever they wanted them and they have not realized the importance of the conservation of cars to the extent that the shippers have been educated to.

In a recent investigation. I found that two systems are being practiced by the roads in handling supplies. On one road they make up a car each month for each supervisor of bridges or each roadmaster, sending him all the supplies he has ordered for that month. That car goes out whether it has 10,000 lb. or 100 lb. in it. I asked why they didn't consolidate cars where they had small loads and I was told that their experience had been that the man getting the last shipment did not get all his supplies as the first fellow had taken more than his allotment. On the other hand the other road had consolidated and was filling cars to capacity. I asked the officers if they were having any trouble and they said comparatively little, because they checked material thoroughly before it left the yard and it was not very difficult to trace the three or four men in whose care the car had been when unload-

ing certain portions for each man took what was on his requisition and that only. It seems to me the contrast between the two systems is an important one because it represents a good many cars. The situation will be much more acute within the next 60 days when railroad men are going to have from 30 to 40 per cent more traffic to handle this winter than last. With that condition confronting us we can see the necessity of the conservation of cars. Cars should be released immediately when they have reached their destination. There is nothing the men in this association can do that will help to win the war more than to keep the cars moving with full loads all the time.

A. H. King:—I think we can assist a great deal in getting proper delivery and saving time on carload shipments by getting in communication with the stores department and increasing our shipments going in certain directions. For instance, a man may have material going to several different points. If that could be explained to the shipping clerk or the man who forwards it at the storehouse it would bring good results.

R. C. Henderson:—The paper doesn't touch much on small shipments. It is very easy to take care of large shipments that you order 30 days in advance, but I would like to have an expression from men on other railroads regarding the handling of the small items.

The President:—The Baltimore & Ohio started running a supply train monthly about three or four years ago and it was quite a while before we got familiar with the method. We finally made our requisitions read so that we could refer to the shipping points by mile posts and telegraph pole number and have them marked clearly. Then the storekeeper loads the supplies so that the first part of the load going into the car will be the last to come out at the farthest point, either by drawing a line or laying a board beween the supplies. We found a great saving in the use of cars by that method. As a rule you can find out and order the material 30 days ahead. Of course, emergency cases will arise where we have to ship by local freight, but we conserve a great many cars by the use of supply trains. Those cars are unloaded and often reloaded with scrap material and returned. The rail unloaders assist a great deal in handling heavy material such as 12 in. by 10 in. timbers, stringers, etc.

P. J. O'Neill:—That sounds good, but I am on a territory where if one leaves material on the ground over night he won't

have any the next morning. We have a monthly supply train, not for the purpose of carrying material out on the job, but more for the distribution of smaller material. We rescued from the scrap heap several old flat cars and box cars that were condemned by the car department as unfit for general traffic. They are practically used only by the maintenance of way department. When I want to send a carload of stuff I simply have it loaded on one of those cars, and send it out to the crew. They retain the car and move it from place to place until they have used that carload of material when they send the car back with whatever scrap they have accumulated on that trip. I find that the pilfering of material from cars in Detroit and Toledo is very small with this method as compared to what it would be if it were unloaded on the ground. If you unload it and leave it on the ground it is entirely gone in three days. We have lost only a small percentage from the cars.

G. T. Richards:—Cars should be loaded to the proper per cent above the marked capacity of the car. All orders should be inspected daily and requisitions arranged for material going to one or more divisions in the same locality. If a maximum car load cannot be obtained by loading for points on the division over which the car will pass, small items should be loaded for stations at nearby points on the division and the material billed "off at junction."

To avoid delays of delivery and proper unloading, the loads should be so arranged that material may be readily removed from the car upon arrival at each station along the route. As a further precaution our (C. M. & St. P.) shipping notice, form 229, indicates all stations for which the car has material. All material in cars of this nature is tagged separately with the names of consignee and station.

Material should be shipped in as compact form as possible. Doors, windows and other items of manufactured material which may be assembled on the job readily should be shipped "knocked down," and where necessary the several parts should be properly marked to aid in assembling. All material for one job should be shipped in carload lots as far as possible, as for example, in shipping a complete tank,—the tub frame, hoops and fixtures should all go forward in one shipment.

We can ship a great deal of material by double-decking the loads. One or more scows may be placed one above the other

where we formerly loaded but one on a car. We often load 20 in. to 30 in. concrete pipe over a layer of the larger sizes.

In the selection of cars one should see that, when loaded, they move in the right direction, in order that when empty they can be turned over for loading again with the least empty movement. Coal cars especially, when loaded with anything but coal, should be headed toward the mines.

E. C. Zinsmeister:—(By letter)—The shipping of company material economically, while at the same time reducing the use of cars to a minimum, is a broad question and requires considerable planning where other than full carload lots are shipped, consisting of material too bulky to make local freight shipment. My recommendation is to have all bridge and building material assembled at one point at store department headquarters, where it can be piled systematically and proper facilities provided for handling to and from cars. In cases where less than carload lots are required, generally a carload lot can be worked up by shipping the material for more than one job on the same car.

Each division should be equipped with a crane car for the handling of heavy materials, bridge girders and the like. In this connection, a clam shell bucket is valuable for use in unloading sand, gravel, or crushed stone such as is sometimes received in flat bottom cars and for excavations where small abutments and piers are built where the traffic will permit of such operation.

ESSENTIAL WORK

By C. A. Morse,

Assistant Director, Division of Operation, United States Railroad Administration

You are meeting at this convention under new and strange conditions. You have heretofore been in the employ of various railroads. The majority of you here today are the employees of one great railway system, the largest in the world, larger than was ever conceived by Harriman in his fondest dreams of consolidation. You represent practices that have grown up in your respective sections of the country, many of which you have not been able, even with the best efforts of your association, to unify.

Possibly local conditions make it necessary that there should be some variation in the methods employed in different parts of the country, but in the majority of cases, there is no reason why you should not follow a standard practice. Some of you are still line-spiking ties on pile and timber trestles, and are not convinced that this is not the best practice. Some of you are still dapping guard rails, and insist it is the only proper method. Possibly some of you are still using a mortise and tenon on frame trestles. We all know that there is more variety in the practice of bridging than is necessary, and more than any one road would permit on its different divisions.

All of you who are connected with roads taken over by the United States Railroad Administration are now in the employ of one management for the time being at least, and it should be your endeavor to standardize the methods of bridge work on this consolidated railway. Your association is best equipped to do this, and you should, if you have not already done so, say what is the best practice in regard to these things where there is such a difference in the present practice. I would suggest that, in your program for the coming year's work, you go into this matter and be prepared to make recommendations.

In the meantime, we have a condition before us that we have to meet,—a scarcity of labor and of material with a big business on our railroads, our problem is to determine how are we going to take care of this business safely under these conditions.

We all know that it is possible to extend the life of pile and timber trestle bridges indefinitely by replacing each year, the separate items that go to make up the structure. Also in ordinary times it has been considered wise to renew a structure completely when it has reached a certain stage, using the salvage for repairs that would otherwise require the purchase of new material. Now with both labor and material obtainable only in limited quantities, and knowing that we can carry a structure over with perfect safety by only making partial renewals it is up to us to do so. Again we are using, or have used in the past ten years, large quantities of treated material, especially creosoted material. Today it is impossible to get creosote in sufficient quantities to fill our requirements, and to renew bridges completely with untreated material means a comparatively short-lived structure. In repairing structures to extend their life from one to five years, we should use untreated material as it is much easier to secure it than treated timber.

A few years ago railroads could borrow money for additions and betterments for four per cent and under those conditions it was not economical to spend over four per cent of the cost of renewal in repairs that would extend the life of the structure one year. As la-

bor and material were costing much less then than now this did not permit very extensive repairs to be made.

Today, however, money for Additions and Betterments expenditures is costing from 7 to 10 per cent, and labor and material, when they can be had at all, are from 50 to 200 per cent higher than they were a few years ago. These conditions are due to the war which we all hope and believe cannot last over one or two years longer at the most, when they will be changed. Therefore, we are warranted in making large expenditures for repairs at this time, especially for those that will extend the life of the structure until after the war, when renewals can be made for probably 25 per cent and possibly 50 per cent less than they can be made for at this time.

It behooves us, therefore, to make a careful inspection and study of each structure, and if we can repair it so as to make it good for say, four years for 40 or 50 per cent of what it would cost to renew it in full, we should make the repairs. If we can make repairs that will extend the life of a structure 1 year for say, 7 per cent, 2 years for 8 per cent per year, and 3 years for 9 per cent per year on the cost of renewal, such repairs should be made. It will be seen that if this policy is carefully carried out, we will be able to get through the year 1919, with few, if any full renewals of pile and trestle bridges, and that in doing so, a very great saving will be made in both labor and material, and especially in the latter.

The same careful inspection and study should be made of our steel structures. In the first place, they should be kept well painted as nothing gives added life to a steel bridge for so little money as to keep it well protected with paint. Many structures that are a little light can be taken care of by strengthening if in important main lines, and by reducing the speed of trains if on less important lines.

We are all ambitious to improve the class of structures on the territories under our jurisdiction, and rightfully so, in ordinary times. We all have our schemes for strengthening structures to permit heavier wheel loads from which economical operation can be secured, all of which is perfectly proper and laudable, but in times like the present, we must put such work on the shelf, and bend our efforts toward holding to what we have, leaving such things to be done when we are not fully occupied in the one great task of winning the war. We can afford to stop the wheels of progress temporarily, as, if we do not win the war, there will be nothing to make progress for. Let us hold up our ambitions for the time being, and bend every effort to conserve men and material to the end that we may put the Hun where he will work for us, rather than we for him.

We all have waterways that are not large enough for the areas drained. Many of these have been in this condition for years. We naturally are trying to remedy this a little at a time, and rebuild some each year. We should not do any of that class of work during these times, unless where washouts have occurred recently, and then only if we find that there have been previous washouts at these same places within the last two or three years. We can afford to take a chance where this is the only washout there has been at a point for six to ten years, and hold up the work until labor and material conditions have improved.

On building work, the question of replacing old depots is usually up to the management and as there is little chance of state or local authorities making demands for better depots at this time, repairs to present structures are about all that you have on that class of structures. While you cannot do much new building work, you should endeavor to keep the present structures painted, both for looks and to extend their life. This applies not only to structures, but to roadway signs. In keeping the latter well painted you add to the safety of operation. Signs are erected for a purpose. In order to serve that purpose they

must be seen, and a well painted sign is more readily seen and attracts the attention quicker than an unpainted, weather-stained sign, that looks as though it was obsolete, and was there only because some one had negleced to take it down. The actual cost of painting roadway signs is small, while there is nothing on a railroad that makes it look more alive and up-to-date than well painted roadway signs.

Mechanical department buildings are constantly requiring replacement due to the increased size of power; and there is little opportunity for the bridge and building department to do anything in the way of controlling expenditures along that line. There is, however, one thing in connection with buildings where they do have it in their power to make a great saving. That is in connection with the heating. It is surprising to see how little attention is paid to keeping depots and mechanical buildings like shops and roundhouses tight so as to keep out the cold, and keep in the heat.

Good work can also be done in keeping steam, water and air pipes and valves tight and prevent leakage, which means fuel for pumping water and air, and the making of steam. There is no comparatively small maintenance matter where so much can be saved as in this one thing. With the coal situation as bad as it is in this country today, a special effort should be made to do everything that will tend to conserve fuel. Steam pipes should be lagged, windows and doors should have weather strips, floors should be kept tight, and the bottoms of buildings where cold can get under the floors should be boarded or banked up, broken window panes should be replaced promptly and every effort should be made to save fuel. In many cases in the northern climates, double windows and storm doors should be provided.

In many sections of the country, and probably on nearly every line of railroad, there still remain some wooden platforms at depots. As these require renewal, they should be replaced with earth embankments where there is any appreciable amount of filling necessary; these earth embankments should be covered with stone screenings, gravel, cinders or something of that class, (where little or no filling is required, the earth can be omitted,) and do away with the use of wood in these platforms. This applies to platforms at small stations, where it is not planned to put in brick or concrete.

I always associate a master carpenter with the old time freighter, who had on the back of his wagon a "Jockey Box." In this jockey box could be found anything from baling wire to a wagon-hammer, if anything happened on the road he could always find something in his jockey box with which to repair it. A master carpenter's headquarters shop together with outlying buildings is usually a great big "jockey box" from which he can dig up something with which to do any ordinary job, without waiting for the material ordered on his requisition to show up.

I remember dropping into an old time master carpenter's office one day, where I found him buried in copies of requisitions and completion reports. I asked him what he was doing. "Well," he says, "I built several new pile bridges and repaired several more for which I had sent in requisitions for material; the material has just shown up, although the jobs have been done for two months. I am trying to straighten out the charges on those structures, to make them fit the material that I have just received on the requisitions." I have no doubt you have most of you had similar experiences, and that you have material hidden out that was long ago charged out to some job.

If you have not already found it necessary to do so, I would suggest that, regardless of the nature of the "jockey box," in these times of conservation, you should clean out the box, and get all of this material into use. This is no time to have material lying around idle with the idea that it will come in handy sometime; now is the time when it should be used.

Some of the things that accumulate on a bridge and building foreman's hands are packing, O. G. washers and chord and sway brace bolts. This occurs especially where wooden bridges are constantly being replaced with concrete structures or pipe. I have noticed that it is hard to separate a foreman from this class of material, but all surplus material of this kind and all metal scrap should be shipped in to the storekeeper now, while material and scrap are both so valuable.

I want to say a word to your bridge engineer members regarding their second hand material yards or their jockey boxes. They should be inspected carefully; material that can be used for strengthening bridges should be kept; girders and I-beams that can be doubled up should be listed and used as soon as possible and the balance should be scrapped.

It has been customary to save a lot of light girders and pony trusses for possible future public road crossing use. I believe we are warranted at present prices in scrapping all such as we will probably be able to buy new spans, designed purposely for road crossings, by the time we would use these, and get them for less or at least no more than we can get for these as scrap at this time.

My thought is that with the present high prices for all material and scrap, a special effort should be made to clean house, using what is usable and selling the balance to get rid of it, and then start with a clean slate when normal times come again.

One of the bridge and building foreman's fads is "Jacks" and if left alone each foreman would have a jack of every size he might possibly have use for if only once in five years. Every time he has use for a certain size or style of jack, he makes a requisition for it and if times are good and there is much work going on, nine times out of ten he gets the jack regardless of the fact that some other foreman on the division has a jack like it lying idle. Some of you will take exception to this statement, but when you get back on the job, have a report sent in by every foreman of the jacks he has, and you will be surprised at the results. Then if you will make up a list of the jacks a foreman should have on regular work and plan on keeping at division headquarters a few pairs of the odd sizes that are only required by a gang foreman once in three or four years, you will find that you will not have to pass a requisition for a jack for the next two or three years at least.

There is always an accumulation of odd sizes of timber which is not standard. Now is the time when bridge engineers, architects and master carpenters should get a list of this material from the store department and, regardless of standard, plan buildings and odd structures so as to use it. We will accomplish two things by this,—get rid of a lot of dead stock and cash it in at a very high price.

There is usually an accumulation of window frames and sash, door frames and doors, window weights, etc., that should also be used. Glass is high like everything else; by getting after this matter, we can use it at this time, and by so doing, clean up all of these odds and ends. The same process should be applied to anything that the store department has on hand that is not being called for because it is not standard practice for the time being, on that particular road. Material is too scarce, and costs too much in these times for one to be finicky about standards.

The master carpenter is one of the main stays of the division superintendent and of the bridge engineer and while, like all the rest of us, he has his pet hobbies, he is a valuable and important part of the divisional organization. He is usually a man of sound judgment, has good executive ability and is thoroughly dependable. One of the grandest sights I recall has been to see a master carpenter come out and take charge of the rebuilding of some big structure that has washed or

burned out. Talk about your generals in a big battle, he is surely one of them. "Long live the master carpenter."

Your bridge engineer members are of great value to your organization, being able to get a broader view of the bridge problem owing to the larger territory that they cover, and to the technical training that they bring into their work. As the master carpenter is one of the strong men in the superintendent's organization, so is the bridge engineer in the organization of the chief engineer.

Responsibility makes strength in all classes of men, and the responsibility that the master carpenter has for the bridges on his divisions, and the still greater responsibility that the bridge engineer has for all of the bridges on his railroad; have necessarily made each of them a strong and reliable member of the maintenance organization. This is reflected in your association and gives its findings and recommendations strength with all who know the class of men that compose it.

I hope that we shall have the benefit of the best judgment of such men and others that compose your organization in helping to solve the question of how we are to keep up the efficiency and safety of our railroads during the period of war, while men and materials are so hard to get and when the part that the transportation system plays in this war is so important. No one can do it better. You are all essentially, emergency men. The emergency is here now, the greatest in the history of the world. Pull off your coats and get into the game. Show the country what you can do. It's in you to beat the Hun, so go "over the top" and help get him.

THE STEEL SITUATION

By T. C. Powell,

Members Priorities Committee, War Industries Board

The Nation's present business—your present business—is War. When this fact shall have taken firm root in the hearts and minds of the men, women, and children of this country our industrial problems will be found comparatively easy of solution, and the task of readjusting and mobilizing the industries of the Nation to meet the requirements of the military program more than half discharged.

For the winning of the war steel is now the world's most precious metal. It is consumed, or used to some extent, every day by practically every civilized man in every civilized country, and nowhere in such vast quantities per capita as in the United States. The present and constantly increasing steel requirements of this country and its allies for direct and indirect war needs, 100 per cent of which must under any and all circumstances be promptly supplied, are so enormous as to well-nigh absorb our constantly expanding producing capacity. The result is obvious. There will be comparatively little iron and steel left to distribute to those industries engaged in non-war work and to consumers for application to non-war uses. Every possible use of iron and steel or their products which can be deferred must be deferred until after the war. This duty is **personal** and can not be avoided or delegated to your friends and neighbors. No consumption is so small as to be immaterial, and no saving insignificant. Every pound collected and sold to scrap-iron dealers finds its way back into the general supply of iron and steel. "The last quarter hour will win the war," and in that quarter hour the last shell will be fired. That shell may be made from steel that has been saved through the collection of scrap or through denial of the luxury of purchasing steel in the form of articles which have come to be regarded as peace-time necessities.

Among other tasks which the President has laid upon the War Industries Board is that of so distributing the supply of iron and steel available, or which can be made available, as to meet the war requirements and as far as possible the essential needs of the civilian population. This task is being discharged in part through the administration of priorities.

The term "priority" implies discrimination—purposeful discrimination. All priorities are relative and the classifications are based upon the relative importance of the particular industry or the particular plant involved to the war program or to supplying the essential needs (as distinguished from wants) of the civilian population.

Structures, roads, or other construction projects falling within the following classifications are hereby approved, and no permits or licenses will be required therefor:

(1) After having first been cleared and approved by the War Industries Board, those undertaken directly by or under contract with the War Department or the Navy Department of the United States or the United States Shipping Board Emergency Fleet Corporation, the Bureau of Industrial Housing and Transportation of the United States Department of Labor, or the United States Housing Corporation.

(2) Repairs of or extensions to existing buildings involving in the aggregate a cost not exceeding $2,500.

(3) Roadways, buildings, and other structures undertaken by or under contract with the United States Railroad Administration or a railroad operated by such administration.

(4) Those directly connected with mines producing coal, metals, and ferro-alloy minerals; and

(5) Public highway improvements and street pavements when expressly approved in writing by the United States Highways Council.

No building project not falling within one of the foregoing classes shall be undertaken without a permit in writing issued by or under the authority of the Chief of the Non-war Construction Section of the Priorities Division of the War Industries Board.

The Priorities Committee has two divisions, one supervising construction which is immediately connected with the prosecution of the war, and the other, the construction which is non-war. The division in charge of Non-war Construction not only supervises the amount of steel necessary for such construction, but also carries out the plan under which no construction costing above a certain sum can be started without a permit. This division has also undertaken to secure a report from the entire country listing all the building now in progress, including private residences as well as manufacturing plants.

The division of the War Industries Board which handles new facilities directly connected with the war, is in continuous session through the Chief of the Division and his immediate assistants, but in addition to this the Facilities Division holds a meeting every other day and sufficient time is taken to discuss fully the projects submitted by the Army, Navy, Emergency Fleet Corporation, and by the several other divisions of the War Industries Board, as, for instance, the Chemical Division, which works with both the Army and the Navy.

It is recognized that in certain types of construction steel is an essential material, but the Facilities Division does not accept the mere statement that the style of construction decided upon necessarily requires steel, but goes further into these projects to develop whether or not the type of construction cannot be changed without incurring additional expenses and by substituting other available materials, the use of which will conserve steel. The same program is carried out in connection with railroad construction, and in many cases the plans of the railroads or of the contractors working for the railroads, have been modified, substituting concrete for steel, and in some cases, substituting wood for steel.

In the case of bridge construction, the railroad submitting plans for a new bridge or the replacement of an old one is asked to limit the use of steel to the minimum. In the case of shop buildings, the steel is limited to those parts of the building for which it is proved that no other type of construction is possible. Water tanks and fuel oil tanks are being constructed of concrete. Through the War Industries Board also conferences are held with the different industries to see to what extent labor, steel and other essential commodities can be released so that there may be a greater supply for the direct prosecution of the war.

The conservation of material and men is an absolute necessity to the ultimate victory of the Allies. Not only must men and materials be conserved, but the use of the railroad facilities must be limited to necessary transportation and all unnecessary use of them must be cut off. The Railroad Administration is operating the railroads as a unit for war purposes. The development of traffic, the extension of markets and all those activities which are not only commendable but necessary in times of peace, must be considered today from the standpoint of the war. The less waste there is in transportation, the more engines, cars and track facilities will be available for handling troops, munitions, food and the necessary materials.

It is believed that with the co-operation of the people of the country there will be provided a reserve supply of men, materials and railway facilities, and I think we are all firm in the opinion that the existence of this reserve power will be the deciding factor in bringing the war to a complete and satisfactory conclusion.

CARRYING BRIDGES OVER

By C. F. Loweth

Chief Engineer, Chicago, Milwaukee & St. Paul Railroad

Your convention committee is responsible for the subject of this paper. It is to be commended because conservation and "carrying over" are properly watchwords of the day. It is hoped that the paper may be helpful in conserving and carrying over for further usefulness some bridges which, under normal conditions, might not be thought worthy of further service. This paper will deal principally with railroad bridges, but the underlying principles will apply to other kinds of bridges, and, to some extent, to many other structures.

General Considerations

In the maintenance of bridges there are two general considerations to be observed:

1. Safety in carrying the necessary traffic.
2. Economy—that is, obtaining the maximum life from the structure at reasonable maintenance cost.

The necessity for renewing bridges usually arises from one of the following causes:

1. Physical deterioration.
2. Overloading.
3. Rearrangement or relocation.

Physical deterioration usually limits the life of timber bridges and occasionally limits the life of steel bridges in certain situations, such as viaducts over railroad tracks where corrosion and general deterioration is much more rapid than usual for such metal bridges.

The necessity for the rearrangement or relocation of bridges usually arises from conditions outside of the structure itself and need not be further considered in this discussion.

On all railroads which are 25 or more years old, there are usually a number of light-capacity bridges which impose more or less restrictions on the train loadings that can be handled over those lines. This is a very serious problem on lines which have many bridges which were built during the 80's and early 90's.

New bridges are usually designed for the heaviest engine and car loadings in existence at the time. In proportioning them there is, however, a certain margin between the unit stresses which are used and the maximum stress which the material can safely carry. This margin provides an allowance for some future increased engine and train loadings, in addition to the contingencies which are usually embraced by the term "factor of safety."

As an illustration of the increase which has taken place in engine loadings, see Fig. 1, which shows in a graphic way the increase which has taken place on the C. M. & St. P. from 1875 to date. One line of the diagram shows the maximum weights on locomotive driver axles at all times during this period. The other line is a more direct measure of the effect of these loadings on bridges and shows the maximum bending moments on 16 ft. spans for the heaviest engines in regular service throughout the period. While this diagram shows the effect only on 16 ft. spans, such as occur in timber trestle bridges, the diagrams for other span lengths would be similar.

These diagrams show that during the period from 1875 to date, axle

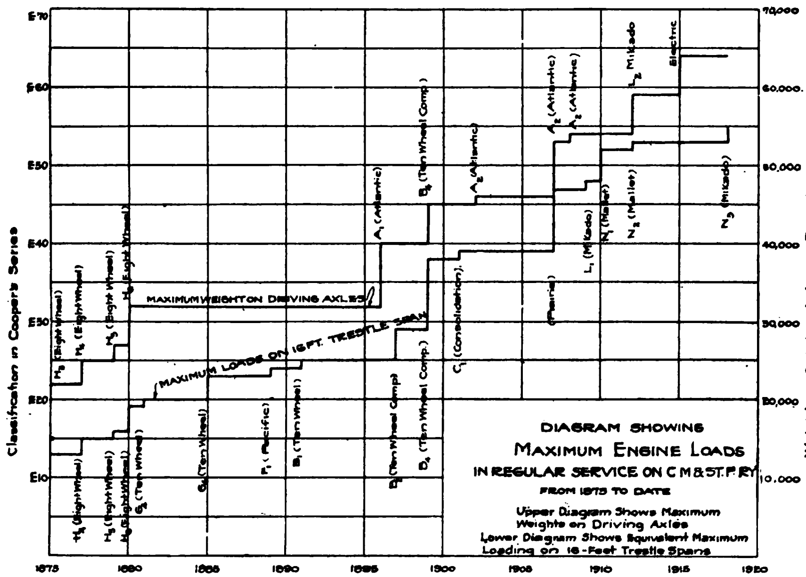


Fig. 1

loads on this railroad have increased from 22,000 lb. to 64,000 lb., or about 190 percent. In the same period the load on trestle bridges has increased from about Cooper's E 13 loading to Cooper's E 55 loading, or about 320 percent. From this it is evident that when the bridges of the period of 1875, and following, were designed, there was no conception of the loads which bridges are now called upon to carry. It is further apparent that these bridges cannot be subjected to present heavy loadings unless their carrying capacity is very carefully investigated in the light of all conditions surrounding the structure.

Classification of Bridges

The term "Classification of Bridges" is used to describe the systematic investigation of light-capacity bridges, with the view to determining the maximum loads which can safely be carried. Formerly, the common practice was, when a new engine loading was up for consideration, to investigate all of the light bridges on the lines where the use of the heavy loading was contemplated. Stresses throughout the structure for this loading were figured and decision then made by the one responsible for the structures as to whether or not the load could be handled safely. Each time a new loading came up for consideration the process was repeated and little or no use made of the previous computations.

The present practice on the C. M. & St. P. is to make an investigation or "classification" of each structure. Its carrying capacity is determined in terms of a standard series of train loadings. New engine and car loadings that come up for consideration are classified in the same series of standard loadings, and it is then a matter of direct comparison to tell whether such proposed loadings can be handled safely over the various bridges. Every bridge whose date of construction indicates that it is of light design, or which is known to be, or suspected of being, overloaded, is thus classified. Every part of the structure is figured or taken into consideration.

Unit Stresses

In making these classifications it is necessary first of all to establish the maximum unit stresses which the various materials can safely be subjected to. For the different materials these maximum safe stresses are taken as near the limit of strength of the material as is considered safe. The maximum safe stresses must be taken low enough so there is no danger of the material yielding, altering its character or reducing its strength to carry loads after being subjected to this limiting stress for any number of times.

As an illustration of what may be considered as safe limiting unit stresses, the following may be taken to apply where the design and physical condition of the structure are known to be first class:

	Wrought Iron	Steel
	Lb. per Sq. In.	
Beams and girders, fibre stress in bending, ...	22,000	26,000
Truss members, tension on net section, ...	20,000	24,000
Timber stringers, fibre stress in bending	2,000	

(With suitable reduction for age for exposed timber over 6 or 8 years old.)

In fixing upon limiting unit stresses for loading old bridges, it is necessary to take into account the following:

Character of design: that the details are well proportioned and direct in action, that there is no ambiguity or uncertainty as to how the members act.

The character of the workmanship entering into the structure as indicated by the reputation of the makers and material test data that may be available.

Deterioration.

Action under load, such as rigidity and freedom from excessive vibration.

The speeds likely to obtain over the structure and confidence as to the observance of any speed restrictions that might be imposed.

The element of certainty as to the assumed loading being the maximum to which the bridge will be subjected.

Importance of traffic and hardship which might result from temporary disablement of the structure.

The probability of early renewal on account of change of line, etc. A higher limit might be allowed for a short time to meet an emergency than for a structure to be kept in service indefinitely.

The general reliability of the data upon which the investigation of the structure is based.

Generally, **judgment** based upon all of the factors surrounding the bridge, its location, service and condition.

It must be recognized that there is danger in setting down a hard and fast rule for the limits to which structures might be stressed. In all cases it is necessary to exercise care and knowledge and good judgment in order to be at all times on the safe side and at the same time conserve the maximum life of the structure.

Standard Loadings

In the systematic investigation of a large number of bridges, it is necessary to have a unit loading as a basis of comparison. The familiar Cooper's series of standard train loadings furnishes a convenient and well-known basis. This series consist of two Consolidation type engines, having a fixed spacing of wheels and a fixed relation between the weights on the various wheels. The weights on the various wheels are directly proportionable to the classes: that is, the drivers for Class E 40 loading, are 40,000 lb. on each axle: For Class E 50 loading, 50,000 lb., etc.

On account of the fixed wheel rearrangement for all classes and the proportionality of wheel loads, it follows that the stresses in all parts of bridges on account of these loadings are directly proportionable to the classes: that is, the stresses in every part of the structure for Class E 50 loading will be just 50 times the stresses for Class E 1 loading.

In addition to the direct weight of the engine and carloads, which are hereafter referred to as "live loads" there are certain effects of the moving load which have to be taken into account. One of these is what is known as "Impact," which is the extra effect of a moving load on the structure over and above the effect of the same load at rest. The result of the moving load is to put the structure into vibration, which results in increasing the stresses at certain points in the vibration. The effect of impact is commonly expressed as a percentage added to the "live load." The formula for impact in common use is, $I = \frac{300}{300+L}$, where L is the length of the train load on the portion of the structure which affects the part of the structure being investigated. This gives a percentage decreasing from 100 percent for extremely short spans, 75 percent for 100-ft. spans, 50 percent for 300-ft. spans, etc. That is, for a 100-ft. span the effect of the moving "live load" is considered 75 percent greater than the effect of the same load at first.

The impact tests which have been conducted by the American Railway Engineering Association have resulted in a new impact formula, which has been adopted by that Association, and which gives a smaller percentage for impact for spans over 100 ft., with slightly greater values for spans less than 100 ft. These impact formulas represent the effect of steam locomotives. It is found that at least some electric locomotives give very much less impact than steam locomotives—roughly about one-third.

Other effects of the moving "live load" are "centrifugal forces" which tend to throw a larger proportion of the load on the outside of the curve and "traction" which is a force exerted along the track, due to the traction of the locomotive or to setting the brakes on a moving train.

In determining the maximum "live load" which can be handled over any structure, it is necessary to make proper allowance for these extra effects of the "live load." It is also necessary to take account of the "dead load" stresses, or stresses due to the weight of the structure itself and wind stresses, due to the effect of wind pressure.

General Method

The general method of investigating any part of a bridge and of making a classification is as follows:

1. The maximum allowable stress is determined which, in the simpler cases, is the cross sectional area of the member times the limiting unit stress allowed.
2. Deduct from this the stress in the part due to "dead load" and "wind load." The remainder gives the allowable stress for the "live load" effect.
3. Divide this by the stress for unit "live load" (Class E-1) which gives the classification for allowed "live load," if at rest.
4. Divide this classification by the term which takes into account the extra effects of the "live load," due to impact and centrifugal force, the result being the classification of the allowed "live load" at full speed.

As an illustration of this general method, the example of the hip vertical member shown as U1-L1 of a truss. Assume that this consists of two steel bars, 4 in. wide by 1 in. thick, giving 8 sq. in. of cross section. If we assume that in this case the circumstances warrant the limiting unit stress of 24,000 lb. per sq. in. the total allowed stress is 192,000 lb. Assume that the dead load stress is 17,000 lb. and that the windload

is so small that it may be neglected. The total allowed stress available for live load is then 192,000 lb.—17,000 lb.= 175,000 lb. The stress in the number for the Class "E-1" loading as determined by the usual methods of computing stresses in bridges, is 1890 lb. The total allowed live load, if at rest is, therefore, $\frac{175,000}{1890} = E\ 92.1$. Impact if taken by the ordinary formula given above is $\frac{300}{300+50} = 0.865$ of the live load. Considering the bridge on straight track, the centrifugal force stress is zero. Therefore, if LL represents the net live load at full speed—

$$LL + .865\ LL = E\ 92.1$$

$$LL = \frac{E\ 92.1}{1.865} = E\ 55.2,$$

which represents the "classification" of the member at the assumed unit stress. That is: An engine with wheels spaced as in the Cooper Loading, having 55,200 lb. on the driving axles, and the other axle loads in proportion, will produce the assumed stress of 24,000 lb. per sq. in. if taken in connection with the other forces which are assumed to be acting.

Classification of Loadings

The class "E" loading above described, is an assumed, typical loading. Actual engines and cars vary a great deal as to spacing of the wheels and the distribution of the weight on the various wheels. The effects of various loadings on bridges are not in direct proportion to the weights of the engines or cars, but depend on the number and spacing of wheels, distribution of weight, etc. Actual engine loadings can, however, be reduced to equivalents in the standard train loadings, cor-

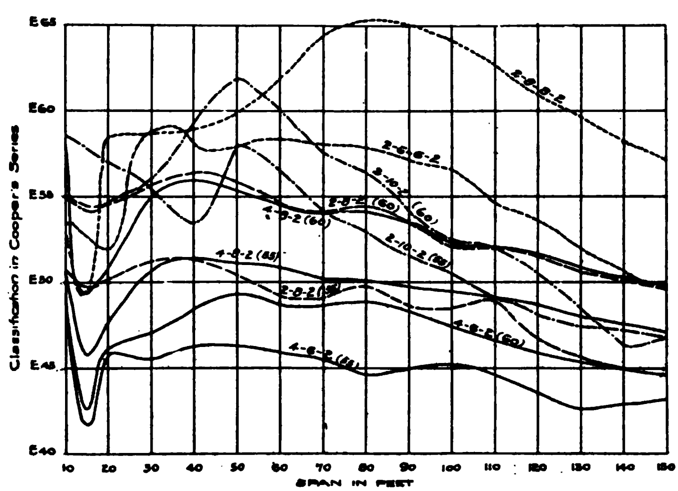


DIAGRAM SHOWING CLASSIFICATION OF
U. S. GOVERNMENT STANDARD LOCOMOTIVES.
FOR MAXIMUM BENDING MOMENTS ON VARIOUS SPANS

Diagrams for E Engines (except Santa Fe and Mallet types) followed by Trainload of 5000 lbs per lin. feet

Fig. 2

responding to the different span lengths. This is done by computing the maximum bending moments and end shears for the given train loading for each different span length. These are divided by the maximum bending moments and end shears for the unit Class "E-1" loading, for the corresponding span; the result being the "Classification" of the loading.

As an illustration of Classifications of various loadings Fig. 2 is given. This shows the classification of several types of the new standard locomotives which have been purchased by the Government and are now being assigned to the various railroads. This diagram shows the classification of the "Mikado," "Santa Fe" and Mallet types for freight service, and the "Pacific" and "Mountain" types for passenger service.

The diagram shows for each of the locomotives the relation between the effect of the given engines on bridges as compared with the Standard Cooper's loadings which are used as a basis for the classification of bridges. The divergence of the several curves from the horizontal shows the differences of the effects of these loadings on the different spans, as compared with the effect of the deeper loading, which is represented by a horizontal line for each class.

Fig. 2 A

Description of U. S. Government Standard Locomotives

		Weights			Wheel Base		
Type	Service	On Driver Axle	Total Engine	Engine & Tender	Driving	Engine	Engine & Tender
Pacific (4-6-2)	Passenger	55,000	270,000	414,000	13'-0"	34'-9"	67'-6½
Pacific,	Passenger	60,000	300,000	444,000	14'-0"	36'-2"	70'-8½"
Mountain (4-8-2)	Passenger	55,000	320,000	492,000	18'-3"	40'-0"	75'-8½"
Mountain,	Passenger	60,000	350,000	522,000	18'-3"	40'-0"	75'-8½"
Mikado (2-8-2)	Freight	55,000	290,000	466,000	16'-9"	36'-1"	71'-5½
Mikado,	Freight	60,000	325,000	497,000	16'-9"	36'-1"	71'-9½
Santa Fe (2-10-2)	Freight	55,000	360,000	532,000	21'-0"	40'-4"	76'-0½"
Santa Fe,	Freight	60,000	390,000	596,000	22'-4"	42'-2"	82'-10½
Mallet (2-6-6-2)	Freight	60,000	440,000	646,000	10'-4"	50'-2"	88'-10"
Mallet (2-8-8-2)	Freight	60,000	540,000	746,000	15'-6"	57'-4"	93'-3"

For example, bridges having a classification of E 55 throughout could safely carry the loadings which fall below the line marked "E 55" in the diagram for the span lengths for which the diagram lies below the E 55 line, but for span lengths for which the diagram is above the E 55 line, bridges would be stressed higher than their classification would permit.

Take for example the Santa Fe locomotive—2-10-2 (55) type, having 55,000 lb. on each axle: It will be noted that for spans under 24 ft. the classification of this locomotive is lower than E 55 loading, for spans between 24 ft. and 66 ft., above E 55 loading and for spans above 66 ft., the classification is again below E 55 loading.

From the diagram in Fig. 2 it will be seen that locomotives 2-10-2, having 60,000 lb. on the drivers, 2-10-2, with 55,000 lb. on the drivers, and the "Mallet" types, 2-8-8-2 and 2-6-6-2 have a classification for 50-ft. spans greater than the limiting classifications of this member of the bridge and could not be permitted to run without speed restrictions.

The other locomotives have a classification less than the classification of the member considered and may be permitted to run over the bridge without speed restrictions, providing no other member of the bridge limits the loading. There is no loading shown in Fig. 5 for carloading which would be limited by this member.

The classification for Pacific and Mikado type locomotives is shown both for single and double-headed engines. It will be noted that for single engines the classification for spans over 50 ft. drops off considerably, while for double-headed engines it is about the same for long spans as for short spans.

Speed Restrictions

In the foregoing the classification has been determined with an allowance for the effect of the maximum speed over bridges. Where speed is reduced the effects of the live load are much less, and the allowance for impact and centrifugal force, if any, may be correspondingly reduced. This will, of course, permit heavier loadings to be operated at reduced speed than at full speed.

From the tests conducted by the American Railway Engineering Association, it is found that the maximum impact which will be obtained at reduced speed is:

Less than 30 percent for a speed of 10 miles per hr.

Less than 40 percent for a speed of 15 miles per hr.

Less than 50 percent for a speed of 20 miles per hr.

Less than 55 percent for a speed of 25 miles per hr.

Where the classification of the bridge indicates that some loadings which it might be desired to run cannot be handled at full speed, the classification for certain reduced speeds should be worked out.

Consider the example of the hip vertical above, for which the live load classification, loading at rest, amounted to E 92.1. For a speed of 10 miles per hour, taking impact at 30 percent, the liveload classification is $\frac{\text{E } 92.1}{1+.30} = \text{E } 70.8.$

For 15 miles per hr. taking impact at 40 percent the liveload classification is $\frac{\text{E } 92.1}{1+.40} = \text{E } 65.9.$ At full speed the impact allowance is 86.5 percent, and the liveload classification $= \frac{\text{E } 92.1}{1+.865}$.

Therefore,

For loads which classify below E 55.2 no restriction to speed.

For loads which classify between E 55.2 and E 65.9 restrict to 15 miles per hr.

For loads which classify between E 65.9 and E 70.8 restrict to 10 miles per hr.

An inspection of Fig. 2, indicates that the effective span of the bridges and the characteristics of the engine loadings determine in a very large way whether or not the given loading can be run over the bridge, and that it is unsafe to attempt to determine whether or not the engine loading can be handled over a bridge simply by knowing its total weight.

There is, unfortunately, a misunderstanding among some railroad operating officials, as to the effect on bridge structures of such complex loadings as locomotives and cars. In these cases it is assumed that the effect is the same for all locomotives of the same total weight, and that the bridges which are classified as being safe, or otherwise, for all locomotives of given total weights. If this practice must be resorted to the limits set must be on a very conservative basis, otherwise there would be danger of certain types of locomotives having a serious effect on some bridges producing unsafe conditions. The practice would not be economical because it would either lead to the premature renewal of some bridges or to an unnecessary ruling off of certain types of engines.

Schedule of Loadings Permitted

After completing the classification of the light bridges on various lines, a tabulation is made giving the classification of the limiting details of each bridge which limits loadings. Classification is also made of all engines in service, single and double-headed, with appropriate train loadings following: also of wrecking derricks and other heavy loads. A list is then made of the loadings which may be permitted to run over the bridges on the several lines, with speed restrictions if any. This is issued in convenient form for use of operating officers.

Where there are a number of bridges on one line which would require restrictions as to speed for certain classes of loadings, it is generally desirable to rule off such loadings, as it is difficult to secure the observance of a large number of speed restrictions. Double-heading of engines should be assumed, and where it is not permitted should be especially noted. The schedule of loadings permitted should also indicate the heaviest car loadings permitted over the various lines.

Where Low Classification Usually Occurs In Bridges

In older bridges there are certain parts where low classifications can usually be expected.

These have been found to occur most often in the lightest members of the structure and members which carry the smallest deadload stresses. This can be accounted for by reason of the low working stresses used for classifying bridges. In proportioning a member, a portion of the area of the member can be taken as carrying deadload stress and the remainder liveload stress. As the deadload stress is constant, a smaller area would be required where a higher unit stress is used. This, therefore, leaves a portion of the area originally provided for deadload available to carry liveload stress.

It is found that the floor systems of bridges generally have a lower classification than the girders or chords of trusses. The low classification of stringers is generally in the section of the flanges near the center, the riveting in flanges near the end of stringers particularly if they are shallow, and in the riveting connecting the stringers to the floor beams. Floor beams, if of shallow depth, frequently show a low classification in flanges near the stringer connections, also in the riveting in flanges near the ends of the floor beams and in splices connecting the webs of the floor beams to the gusset plates, particularly in types where the lower part of the floor beam is cut out to fit around the ends of the trusses.

In plate girders the flanges frequently show low classification at points where the web is not fully spliced near the center and at points near the ends of cover plates. The flange riveting near the ends of girders frequently has a low classification, particularly where the girders are shallower at the ends.

Webs of plate girders show low classification near the ends of the girders where there is a relatively large expanse of web, unsupported by stiffeners. The web splices near the end of the span have a low classification where only one line of rivets is used in each side of the splice.

In trusses, the posts and diagonals near the center of the span usually show a low classification. This is particularly true of the diagonals and counter-diagonals of light eye bars or loop rods.

Suspenders, or hip vertical members, frequently have a low classification. The classification of end posts and top chords of truss bridges is frequently low on account of the eccentricity of the member with respect to the location of the pin.

The pins of old truss bridges frequently show a startlingly low classification where computations are made in accordance with the usual methods and it is necessary to take advantage of certain conditions which are more favorable than the usual assumption to help out the classifica-

tion. Where eye bar members, consisting of more than two eye bars meet on a pin, a slight redistribution of stress in the several eye bars will frequently increase the classification of the pin, and this is justifiable as being in line with the way the structure actually works.

Where certain members have wide bearing surfaces on the pins, the center of pressure can be taken near one edge of the bearing surface, and thus increase the classification of the pin and, at the same time, approximate more nearly the actual behavior of the detail.

It is also permissible to use higher stress for figuring pins than for the other members of the structure. The following illustrates what might be considered permissible, providing there is assurance that the material is of good quality and the computations take account of all the forces acting:

Wrought Iron, ...	40,000 lb. per sq. in. in bending
Soft Steel (0.1%), ...	45,000 lb. per sq. in. in bending
Structural Steel (0.2C), ...	48,000 lb. per sq. in. in bending
Mild Steel (0.25C), ...	52,000 lb. per sq. in. in bending
Medium Steel (0.35C), ...	56,000 lb. per sq. in. in bending
Hard Steel (0.45C), ...	64,000 lb. per sq. in. in bending

It is to be noted that in bridges built in the later 80's and early 90's hard grades of steel were frequently used for the pins.

In timber trestle bridges, the stringers, in bending, usually show low classification. On account of there being three or more sticks acting together, it is permissible to use a higher unit stress for trestle stringers than for a single stick, as the average strength for the several pieces exceeds that of poorest one.

On account of the exposure to the weather and the deterioration which gradually takes place, the allowed stress in timber stringers should be reduced as the age of the bridge increases. Where the bridges are thoroughly inspected and defective timber promptly replaced and subject to the same general consideration given above, for metal bridges, the following unit stresses might be taken as a safe practice for maximum fibre stress in stringer bridges without allowance for impact:

For stringer bridges 6 years old 2,000 lb. per sq. in. and reduced about 100 lb. per sq. in. for each year following.

The above figures are based on Douglas Fir or dense yellow pine and for climatic conditions prevailing in the North Central states. In more arid regions where longer life of timber may be expected, the reduction in stress for age need not be so rapid.

On account of the comparatively short life of timber bridges and the ease with which they can be renewed there is not generally the same urgency in establishing maximum safe stress limits as in the case of the more permanent metal bridges. In timber truss bridges the lowest classification usually occurs in the floor beams, in truss rods and diagonal braces.

It has been found that metal bridges suffer frequently from corrosion at the top flange of stringers and floor beams on account of action of brine drippings from refrigerator cars.

In bridges where ties are supported on shelf angles, riveted to the web of the girders, the shelf angles frequently show considerable corrosion and tend to break in the root of the angle. In pin connected trusses, excessive wear sometimes takes place in the pin bearings, particularly in draw bridges.

Metal bridges and viaducts over railroad tracks frequently show excessive corrosion in the floor system and laterals due to smoke and gas from locomotives, also from the fact that the solid floors of such bridges do not permit the steel work beneath to dry out quickly.

Metal over-head bridges having a scant clearance, so that the stacks of locomotives come close to the steel work, frequently show excessive wear from the sand blasting effect of cinders from the exhaust, particu-

larly on ascending grades where the locomotive is worked hard under the bridge.

Possible deterioration of the structure of the metal itself has in some quarters been a matter of apprehension, but it now seems to be recognized that no such internal deteriorating action takes place where the bridge has not been subjected to excessively high stress; if crystallization is found in the metal of a structure, it probably was there at the time the structure was built, on account of improper methods of manufacture of the material.

It may, therefore, be taken as a certainty that iron and steel bridges, if not reduced in section by rust, etc., and if not shaky on account of inadequate bracing, are fully capable of carrying the figured loads at reasonable limiting unit stresses, provided they are carefully inspected and properly maintained.

Strengthening of Light Bridges

Strengthening of light bridges may be either a matter of reinforcing minor details, which are found to limit the carrying capacity of the bridge, or may consist of heavy reinforcing in an attempt to increase the strength of the structure throughout.

The minor strengthening can usually be done at small expense and is an economical method of getting considerably greater life out of bridges. Heavy reinforcing may or may not be economical, as it involves work being done in the field which is expensive, and the maintenance of traffic during the time the work is in progress, which involves some risk to traffic, and is unusually expensive. On very large bridges where the cost of replacing amounts to a very large sum, some very extensive strengthening operations have been carried out economically.

In making plans for reinforcing bridges, it is usually preferable to add new material to the structure so that the present structure is not weakened temporarily, rather than to remove parts and substitute heavier ones, though the latter has sometimes to be resorted to. The descriptions of the points at which low classification usually occurs suggest in themselves how these might be strengthened.

In plate girders the top and bottom flanges may be strengthened by additional cover plates, particularly at points where the web is spliced and not effective for carrying its proportion of the bending stress. Where there are no cover plates on the girders, cover plates of desired length can be added. On plate girders where there are two or more cover plates, additional cover plates would be nearly the full length of the girder and expensive to apply. Plate girders can be doubled up to make deck spans, using three or more girders per span at small expense and thereby using up light girders and providing bridges of large carrying capacity.

Where waterways or other undercrossing conditions permit, timber bents can be placed under spans to strengthen them.

Where the rivets in the flanges of girders show low classification, larger rivets can be substituted for existing rivets, or, where the rivet spacing permits, additional rivets can be driven.

Where the web plates give a low classification, additional stiffeners can be placed in the panels near the ends of the girders to give additional support to the web and increase its classification.

Shelf angles can be strengthened by short vertical stiffeners beneath them. Where web splices with low classification occur, these can be replaced with wider splice plates with additional rows of rivets in the splice.

In through bridges the stringers can be reinforced by additional riveting, by the placing of additional stringers of either timber or steel, and by shifting existing stringers to secure a better distribution of the load. Where stringers are spaced so that some stringers do not carry their full proportion of load, it is possible to introduce cross bracing so that all the stringers in the panel act together to carry the load and relieve an excessive load on certain stringers.

Floor beams can be reinforced by cover plates or angles added to the flanges, by additional riveting, or by shifting the stringers toward the trusses, to reduce the bending in the floor beams. In very old bridges floor beams are frequently of much lower classification than the remainder of the bridge and can sometimes be replaced with entirely new floor beams at a reasonable expense so as to get additional life out of the remainder of the structure.

In trusses, diagonals and counters can usually be reinforced with additional bars or rods with loops over the truss pins and connected by turn buckles to provide adjustment. Similarly, botton chords of eye bars can be reinforced with additional bars with yokes bearing on the heads of the original eye bars.

End posts of through bridges, whose low classification is due to eccentricity of members, can be strengthened by placing angles or plates on the sides of the members, so as to make the cross sections better balanced, and reduce eccentricity.

Where pins have low classification, it is sometimes possible to move the members on the pin to reduce the bending. In some cases, diaphragms placed inside of built-up numbers will relieve bending on the pin. The pins themselves can be strengthened by replacing them with high carbon, or special alloy, steel pins of the same size, or, if additional strength is required, by boring out the pin holes and putting in larger pins. This operation has been done a number of times, but requires rather elaborate arrangements for holding the members in position while the pins are removed, and for boring the holes.

Timber truss bridges can be strengthened by placing additional floor beams, diagonal braces or truss rods where needed.

Where timber trusses are old and have commenced to open slightly in the joints or show other signs of diminished strength, they can be strengthened temporarily and carried for a few more years by placing timber bents under the panels points, two or three panels from the end of the span. This has the effect of reducing the span length and stiffening the span.

Timber trestle bridges can be strengthened readily by additional stringers.

The cost of strengthening bridges varies with the size of the job, the amount of staging required, the amount of moving it about to reach different portions of the work, the size of the crew available, the distance traveled by crew, tools available, etc. In a general way, it has been found that the cutting out and replacing of rivets on ordinary strengthening jobs costs from 25 ct. to 75 ct. each. Drilling and driving new rivets, 50 ct. to $1.00 each; that is, the cost of such work will be given by the total number of rivets driven at these unit places, plus the cost of additional material required.

With the maintenance of old bridges of light capacity, the question continually arises whether it is more economical to strengthen the structure or renew it. As a general proposition it would be permissible to spend each year for strengthening an amount equal to the interest on the investment in a new bridge, less the cost of additional maintenance required by the old bridge on account of the greater attention it receives.

For illustration, consider a few lengths of through spans designed for E-55 loading, replacing similar spans designed in the early '90's, new steel work being taken at 5 ct. per pound erected, falsework at $10 per lin. ft., removal of the old structure at $10 per ton, salvage on old spans at 2½ ct. per pound, additional cost of maintenance of the old span on account of additional inspection, classification and supervision required, $1 per ft. of span per year. The last column of the following table shows the amount which we could afford to spend per year in strengthening old spans rather than to renew them. The costs shown in this table are for

Span	New Steel Weight (pounds)	New Steel Cost Erected	Salvage	Net Cost	Interest on net cost at 5 percent	Available for strengthening each year
50'	66,000	$ 4,330	$ 1,130	$ 3,200	$ 160.00	$ 110.00
100'	218,000	13,390	3,700	9,600	480.00	380.00
200'	800,000	46,800	12,500	34,300	1,715.00	1,515.00
300'	1,600,000	92,200	25,000	67,200	3,360.00	3,060.00

illustration only. As they fluctuate from time to time the resulting economies will vary accordingly.

The writer has in mind a bridge having three 400-ft. spans which if renewed about ten years ago, as some railroad managements might have done, would have cost about $370,000, after deducting the salvage value of the old spans recovered. The interest on this investment for the ten years would have amounted to about $185,000. Instead, however, of replacing these spans they have been carefully maintained and inspected and the details strengthened wherever the classification showed that it was necessary to carry the heavier traffic. The actual cost of strengthening together with the additional maintenance expense has amounted to not over $100,000 during this period, showing a saving for this one bridge of about $165,000 because of the policy of getting the longest practicable life out of the structure.

This illustration is intended to show only one way in which the problem may be considered. With old and light bridges a limit is reached beyond which it is not economical to strengthen them, and replacement then becomes necessary. It must be recognized, of course, that a newly designed and heavy structure is preferable to a lighter one. It is possibly true that in case of a serious accident on a bridge, a light structure might be destroyed while a heavy new structure might withstand the same treatment without being seriously disabled. Such consideration must be taken into account in shaping the general policy in keeping light bridges in service.

Acknowledgment is here made of the valuable assistance in the preparation of this paper by R. L. Stevens, assistant engineer on the C. M. & St. P., who has in the past aided largely in the work of classifying the bridges on that railroad and has prepared the data which has been worked up in the illustrations and diagrams herewith.

DISCUSSION

(Carrying Over Bridges.)

The President:—We will now take up the discussion on Mr. Loweth's paper.

E. T. Howson:—One thing to which Mr. Morse referred in his paper yesterday is closely allied with the subject in Mr. Loweth's paper; that was that we could afford to spend a lot more now in repairs to carry structures over than we could under normal conditions. The cost of doing work is so much greater now on account of the higher charges for labor and materials and the

delays which necessarily ensue, that, as Mr. Morse said yesterday, we can afford to spend up to 30 or 40 per cent of the cost of a new structure for repairs that will carry a bridge three or four years longer or until we return to normal prices. That situation is being brought prominently before railroad men now by the difficulty the Government is encountering in closing negotiations with the roads for the acceptance of cars. The United States Railroad administration ordered 100,000 cars and distributed them between the railroads which it thought needed them. The officers of these roads are hesitating about accepting those cars now and paying for them at the high prices which now prevail. As a result the Railroad Administration finds itself with 100,000 cars on hand and many railroads unwilling to take them over and pay for them.

The situation with reference to bridge work is the same. It costs so much more than in normal times to renew bridges that if a bridge can be carried over, even by extensive repairs, it is well worth while now. It used to be that the repairs justified would be a relatively small per cent of the cost of a new structure, but that per cent is greatly increased now.

L. D. Hadwen:—The point Mr. Howson just emphasized raised another question in my mind,—whether our bridge inspection in these times is sufficient, or, if enough attention is being given to the possibility of carrying our timber bridges a little longer? The general attitude of bridge inspectors is to play safe. For this reason there is danger of their recommendations being a little premature. I think it behooves everybody connected with the maintenance of bridges to bear in mind that it is advisable to give very serious consideration to any recommendation for the renewal of timber bridges.

J. S. Robinson:—I think we ought to bear in mind, that in trying to carry over old bridges we must inspect them more often than we have been, being particularly cautious that old bridges are kept safe, that no member in a truss or any other kind of bridge is unsafe. That requires very close examination. Any member might fail under heavy loads now and not be observed unless it is looked over carefully.

Lee Jutton:—The paper which has just been read had to do mostly with the larger structures. Such structures are handled by the higher officers and are carefully studied before a decision is reached. On every railroad a lot of minor repairs are made with-

out anybody perhaps knowing about them except the local foreman, or the district foreman. I think we ought to get a little different viewpoint into those men's minds and have them think twice before they renew planking, ties, etc. They all have standards to go by, but all standards are now being put aside and a second thought given as to whether that work should be done immediately. That was brought to my mind because of a little pamphlet on fuel in which it was shown that 90 per cent of the fuel used on railroads is locomotive fuel and the other 10 per cent for other purposes, such as heating plants, pumping stations, etc. Figures were given to show what an enormous saving could be made by conserving a small percentage of this 10 per cent.

It is all right to study the large bridges carefully and where we used to rebuild them to carry them over by reinforcing them. While it is also very important that a man should make small repairs, it is just as important that he give these things careful consideration and think twice before he makes repairs that ordinarily he could do without.

R. H. Reid:—On the New York Central repairs on bridges are laid out by the bridge supervisor, even the renewal of ties, the tightening of bolts, repairs on ribbons or so-called outer guard rails and everything else. In these times, of course, many of those minor repairs have to be cut out.

Now, on bridges of both steel and wood we frequently find a few poor ties. If those ties are scattered they are left until a more urgent time. In the same way the ribbon may be sap rotten, but as long as the ties are in place and there is no evidence of the ribbon letting go it can be carried over. The stringers will frequently show decay at the joints near the ends while they may be sound in the middle. Generally the joints over the bearing will stand considerable decay before they give out. The same is true of the caps. They may show decay in certain parts, especially at the end, but there is no immediate need of renewing those caps. In ordinary times when stringers show certain conditions it may be well enough to put in extra stringers and release or take out the decayed ones and replace them, but in times like these such work can frequently go over until labor and material are more plentiful.

Where we have I-beam stringers in steel bridges which have become too weak with the increase in weight of motive power and of cars we have replaced them with wooden stringers. In other

cases where wooden stringers were not heavy enough we have replaced them with second-hand I-beams sometimes taken from other spans. In other cases we have taken plate girder spans from tracks that are now unused and installed them where they were more urgently needed.

A. H. King:—It seems to me that conditions today as far as repairs are concerned are not much different than ordinarily. I remember during all the time of my service that we have been expected to know if a structure was safe and if on our regular inspection we found that there was anything we thought was unreasonable or unsafe we were supposed to get busy. We have always had plenty of material to make a structure safe. All I can see to the problem today is that we have got to bend our energies a little further toward inspection and to make inspections oftener. I don't feel that the general situation is any hardship at all. I am always glad to see the opportunity to work in second-hand material.

J. S. Robinson:—We have cases on our lines where we run refrigerator cars and the dripping from the brine causes bad results. We have found I-beams and deck girders where the flanges were corroded to a knife edge from the action of the brine. We watch those bridges very closely. That is one thing I had in mind in urging frequent inspections of bridges we are trying to carry over. We have carried over a number of girder and I-beam bridges a year longer than intended by watching them closely, scraping off the brine and cleaning them a little. This requires constant inspection and constant supervision but in that way we are able to carry them over. It is difficult to get steel structures now.

A. S. Markley:—The danger of rotten timber in wooden bridges should not be lost sight of. Ninety-nine per cent of the fires result on account of decayed timbers. We should remove all timber that is bad before fires start. Of course, we have sap-rotten timber but we can remove that. We should not lose sight of rotten stringers between the joints and down in the corbel where 90 per cent of the fires originate. We can't be too liberal in our inspections.

F. E. Schall:—Mr. Robinson's discussion brought out a point that I think is very timely, the matter of brine drippings. He said something about flanges being corroded to a knife edge. We have had similar cases. We have had to take them out and

reinforce them. As has been said, this requires close inspection.

In regard to timber, I think Mr. Markley's remarks were very timely. We have been cutting off the sap rot for years. We had one sad experience in which we lost about 3000 ft. of tracks through fire on Newark Bay. You must make closer supervision. Don't let the foremen take the action, tell them what to do. It is harder now than it ever was to attend to your duties in such a way that you will conserve material. The foreman will take the safe course, and many times he will let a crew renew members that could be carried over. The supervisor must keep in close touch with every foreman and tell him what to do. By so doing he can save a lot of money and a lot of material and still be on the safe side.

D. B. Taylor:—Our idea is to have a bridge and building inspection every fall. The master carpenter personally is responsible for the condition of his structures as to ties, painting and the renewal of rivets where corrosion is setting in. We figure on the necessity of cutting so many rivets out and replacing them with new rivets in the upper and lower flanges and in the stringer connections in the floor beams, replacing all ties, repairing masonry or any other work the structure needs, as well as painting the bridges whenever they need it. We count the split and bad ties. By this method it is put strictly up to us to know how every structure is as to caps, piling and everything. We know that the master carpenter personally is in charge; it isn't left to foremen in our territory.

A. H. King:—I wish to say that on our main line of 315 miles, we have strengthened all of our trestle bridges by adding additional stringers on each side and where necessary we have placed an extra post. Another method of conserving timber that I found is working out very favorably, is that of turning or shifting ties in order to get a better spiking surface and to turn down slightly decayed portions. Instead of scrapping our guard rails on account of broken daps, we cut blocks and nail them on the top of the cord to hold the ties in place. I think we save a great deal of labor and material in this way. I don't approve of this so much on main lines as I do on branches where the traffic is not so heavy and the power is lighter.

R. H. Reid:—We have on the New York Central a pile bridge that was built in 1892. In 1903 we put on a new deck. The piles were fairly good but we drove a few extra piles in

each of the bents to strengthen them. That bridge carried traffic until last year when it was renewed. We have timber bridges that were built in 1898 to 1900 that are still carrying traffic. One of these bridges built in 1900 has the original stringers, ties and bents. We have quite a few others that are from 15 to 18 years old. One can make a good job of repairing and carrying over bridges if good foremen are employed.

A. H. King:—We are doing some repair work of a semi-permanent character. When the piles decay badly at the ground line we cut them off a few feet under the ground and build a concrete pier, using the old pile stubs as long as they will last and then substituting frame bents.

R. C. Sattley:—Many bridge men place a stub on top of a pile that has been cut off below the ground. I think it is good practice to indicate in some way that this substitute is a stub. As a general rule a square timber extending into the ground denotes that it is only a stub.

R. H. Reid:—The bridge records should show which are piles and which are stubs. On the New York Central we keep a record of every pile that is stubbed or spliced. If the inspector is onto his job he can tell if it is a stub or a pile from its appearance, but his record ought to be a guide. I do not think there is much economy in cutting off piles and building concrete piers on them and then putting frame bents on those piers. I think it is just as well, if not better, to put the bent directly on the pile stubs, then you can renew that bent as long as the piles remain sound and you know what you are doing.

Something was said about using old stringers to make frame bents. One needs to be careful in doing that; if one uses soft wood stringers they may not carry the load. They are liable to fail by crushing or splitting. I found that to occur in a good many instances where it had been tried on some of our lines which were operated independently before we took them over.

The Secretary:—Mr. Reid says it is better to cut off piles below the ground line and then place bents directly on the cut-off piles. That is putting timber right back into the ground and in certain soils and locations wood rots very quickly. In many locations on the Northwestern, and especially in the western country, we have found it advisable in many instances to build the small concrete piers, then the frame bents come well above the ground and will last as long as the rest of the structure, where-

as they would not last but a short time if they extended into the ground. These piers may then be considered permanent for future wooden trestles.

Mr. Bainbridge:—The discussion has turned more to the minor repairs of timber bridges than along the lines which Mr. Loweth's paper seemed to cover. Mr. Loweth's paper covered steel bridges, the idea being to try and get some standard method or some expression of how the various roads were determining the age or the period when such bridges should be renewed or replaced with stronger structures. There does not seem to be any standard practice in regard to that. We have, for a number of years been trying to improvise a method whereby we could determine with some degree of satisfaction to ourselves when these structures should be taken out and what limiting stresses should be used in determining this.

The paper hasn't touched much on the method adopted by our road in maintaining timber structures. I don't believe there is anybody from any road here who probably has not used nearly all of the methods that have been discussed in maintaining timber structures, cutting off the piles below the ground and putting concrete on top of them, cutting them off and putting other posts in, putting in additional stringers, etc. I think such methods depend a great deal on local conditions, the traffic that goes over the bridge and things of that character.

R. H. Reid:—The first thing to consider in determining the necessity of renewing steel or iron bridges, is the calculation of their loads. We have a pretty good idea of what the loads are going to be or what are proposed and we can determine what the stresses will normally be for those loads. In the case of plate girders, if the stresses are not actually prohibitive, we can let them put the loads on for a while and watch the girders. If there is an increase of say 20 per cent in the loads over what they have been carrying, let them put those loads on for a while and watch the results. If the rivets do not loosen up and there is no danger, then go on until they do. Of course, if there is an increase of 50 per cent in the loads and the indications are that prohibitive stresses will be created it may be policy to take the structure out without further investigation, but for ordinary increases we can safely let them put the load on and watch the structure. We have structures that are from 30 to 40 years old and still carrying our maximum loads and carrying them safely.

In the case of trestle bridges it is not so easy to determine from appearances when loads are becoming dangerous.

Mr. Bainbridge:—I would like to ask Mr. Reid a question. In watching the steel bridges do you figure the load that is allowed over the bridge first or do you let the load go over and see the effect of the load on the bridge? He mentions that he has bridges 30 to 40 years old still in service. We have too but they were designed for our heavier lines at that time and have probably been taken out and put on some of the branch lines where the increase in weight of power has not been anywhere nearly in proportion to what it is on our main lines. We determine what the bridge is, steel or iron, and figure what it is good for at limiting stresses. When the bridge was designed it was probably designed for a certain class, maybe at a stress of 16,000 lb. Now if you increase the stress to 20 per cent and still maintain the 16,000 lb. your increase in load is not going to be very great, but if you increase the stress to 20,000 or 22,000 lb. and you increase the load much more in proportion it will be.

R. H. Reid:—If you increase the load you necessarily increase the stresses in the structure. But we calculate the structure for the load before putting these increased loads on it to see what stresses they are going to give.

F. E. Schall:—The gentlemen gave an idea of what a bridge might be put to. The life of a bridge does not so much depend on the light loads as the over-stresses.

THE CONSERVATION OF MATERIAL

By G. W. Andrews*

It is probably not generally known that the pig iron situation today has become a very serious one, in fact, such that the amount available is only about sufficient to provide for war requirements. This being true, it has become necessary for our Government, through the War Industries Board, to formulate and issue certain rules prohibiting the use for all purposes possible of all materials in which pig iron enters into the production. This, of course, takes in all steel and iron products of every character.

In view of the above condition, the use of cast iron and steel pipe has practically been prohibited for the period of the war, for any purposes where brick, stone, concrete pipe, vitrified clay and wood pipe can be substituted. Knowing as we do the great value of cast iron, wrought and steel pipe, we have been prone to lean toward its use even where it was possible to substitute other materials.

There is absolutely no reasonable excuse for using at this time, metal piping of any character for drainage and sewer or culvert uses on railroad work. For drains under tracks, I do not believe we should ever install anything smaller than a 12 in. opening and for this purpose we should use 12 in. by 12 in. wood boxes made of lumber 2 in. thick and treated wherever practicable. When greater openings are required we should go to 18 in. to 60 in. vitrified clay or reinforced concrete pipe. For underground drains of small sizes, we should use vitrified clay pipes, and where necessary, cover them with concrete. I am fully aware that this does not comply with community laws, but as previously stated, the use of steel or cast iron pipe will be prohibited, and there will be nothing for the communities to do but fall into patriotic line and consent to waive iron clad requirements.

For certain water lines, especially long supply and gravity lines, serious consideration should be given to the use of wood stave pipe. I have recently made a close study of the use of this type of pipe with the result that an order has been placed for 9000 lin. ft. of 8 in. pipe for use as a gravity line connecting high and low pressure reservoirs.

The use of steel, either in supports or water storage tanks, must be discontinued during the period of the war, and timber or concrete substituted. As a matter of economy, the writer's favorite practice of placing from 4 in. to 6 in. of concrete on the bottom and a few additional hoops between the regular lower hoops, should be given serious consideration, not only during the present trying period, but for the future. It will probably be asked what effect this has on the top of the staves. The answer to this is, none. I believe that nearly, if not all of our members, will agree with me that our greatest trouble with leaks is either around the chimes or at the top of the staves. The cement bottom and additional hoops will take care of the chimes and, in many cases, the lowering of the float valve a few inches will take care of the top. Where holes appear on other parts of the staves, they can very often be remedied easily by clamping a piece of 1 in. or 2 in. stuff on the inside. Details have been entered into to fully impress on all concerned the necessity of conserving wherever possible, in the care and maintenance of tanks.

There is no work handled by bridge and building forces, in which

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the necessity for conservation does not enter. For buildings we should discontinue, especially on outlying stations and other small structures, the use of large glass in the windows, substituting wherever possible, sash with small glass, not larger than 12 in. by 14 in.

In painting buildings and bridges, there is unquestionably a great waste in brushes, in many cases the foreman permitting them to remain in the paint cans until they are valueless. It should be the duty of all foremen to see that all used brushes are kept in a softening liquid and in condition for use until they wear out. Receipt should in all cases be taken from each man for dusters and putty knives furnished and these should be returned at the end of the job or on the laying off of the men.

Gutters as well as down spouts on line, or road stations, freight houses, etc., can in many cases be made of wood instead of metal. The life of roofs can be prolonged materially by judicious and proper painting, and even when filled with pin holes they can be preserved by the application of a good roofing cement in paint form.

Water supply offers considerable food for study. More time should be given to the proper training of our pumpers in the proper method of firing their boilers, oiling of pumps, running repairs, prevention and wastage of waters, and the plain exercise of common sense in handling their work.

On timber structures, it will always be necessary to take out timbers of which a large percentage is good. They can often then be used in the same structure for shorter members, but where this is not practicable they should be sent to the company's saw mill for reclamation.

All bolts, packing spools and washers should be saved and where necessary, bolts recut. Any railroad of large mileage that has not established reclamation shops, must certainly feel the need for them at this time, especially in bridge and track work. The company with which I am connected has had such shops in operation for a number of years, and they have proven an economical proposition in the best of times, and a blessing at this time.

In our bridge, frog and switch shop we are at the present time turning out necessary materials, especially bridges, that would be out of range of possibilities to obtain. Let us remember that we must stop and think before ordering new material, no matter how small the item, that it might be possible to substitute for something else. Permit nothing to go into the sale scrap pile that can be used. First of all, train your men, especially foremen, to follow along these lines.

SMALL VERSUS LARGE GANGS FOR MAINTENANCE WORK.

COMMITTEE REPORT

This subject is one that admits of a wide variation in ideas and is one on which much can be said against either small or large gangs. In my opinion the success of either rests with the foreman and his ability to lay out the work and arrange the details so that neither confusion nor discord is permitted to arise.

A close observation and study of men in charge of gangs discloses three classes of foremen: (1) A man who can handle two or three men to good advantage and keep them busy, but whose efficiency as a foreman ceases when he gets more than this number: (2) the man who is capable of handling a large crew of men on a large job but who is "at sea" on a small one and, (3) the man who is the happy medium between the first and second and has the foresight and ability to lay out and arrange his work so that he can keep all his men busy, whether the job is small or large. I believe that a crew composed of a foreman and five to seven men is preferable to a larger one for general maintenance work and that the work is done more efficiently and economically. Take the gang stationed at the average terminal where the men may all work at the same job from one to several days at a time and then be spread out for days at a time with not more than two men working together. Then it is that the foreman has his hands full to look after them to see that the work is done properly and that they do not lack for material. Here is where the small gang is preferable to the larger one from an economic point of view, as it gives the foreman more time to oversee the work. At the same time we all realize that the closer the supervision the better will be the results obtained.

A road gang should have about the same number of men as a terminal gang for various reasons. Take for example a job of renewing bridge ties or cutting off piles and putting on frame bents. A gang of from 6 to 7 men can work to good advantage without getting in each other's way and can accomplish practically as much as a larger crew on the average job of this kind, especially where the traffic is all heavy. The framing can be done while waiting for trains, and timbers can be put in after trains have passed, where if too many men are working the framing can be done faster than the timbers can be used, making it necessary for the men to be idle a part of the time.

On building work we have many jobs on which it is very difficult to keep even six or seven men employed to good advantage. This is where a foreman can show his ability by keeping a close watch on the progress of the work being performed by each man noting how soon he will be through with his present task and then having another ready. Again small emergency jobs turn up at points distant from where the gang is located which requires the service of from one to three men. While this work is in progress there are usually minor repairs at other points to be taken care of which the foreman can have done by other members of the crew so that the whole gang is working to advantage. I believe the average foreman plans his work when he goes to a job and organizes his forces accordingly. If a large gang is employed, when these small and emergency jobs come up and he has to send a part of the gang away it disorganizes the entire force and good results cannot be accomplished.

J. P. Wood,
Chairman.

DISCUSSION

(Small Versus Large Gangs)

R. H. Reid:—I think the report covers the ground pretty well. One point might perhaps be mentioned to bring out a little more clearly the idea that for ordinary maintenance and repair work a small gang will perhaps serve the purpose more economically than a larger gang; for construction work and especially iron construction work, usually a larger gang is necessary, especially in the case of the erection of truss bridges. Ordinarily a small repair gang can work under the division engineer or the division forces but as a rule the larger gangs on construction work are more transient. They are so-called floating gangs and move from place to place where the larger jobs are under way. For those cases I think the larger gang is preferable but in my experience I have found that for ordinary repair and maintenance work the small gangs are more economical as they lose less time. On heavy iron construction and erection work a small gang cannot make any headway at all. They are not able to handle the pieces. You need a large gang for that.

J. P. Wood:—In getting up this report I referred to general maintenance work. I realize, as Mr. Reid says, that where you have larger jobs they require a larger force of men.

The Secretary:—A great deal depends on local conditions and more particularly on the importance of the job. If one encounters a large emergency job which must be done in a hurry he must necessarily arrange for a large crew or double up several small ones. As a general rule, on ordinary maintenance work, small crews can work to better advantage in many respects.

J. Dupree:—It has always been my policy to assign my men their work the night before they are supposed to do it. Two fellows may be painting, two other men may be putting in pipe. I don't wait until 7 o'clock in the morning to tell them what they are going to do that day but I have it all mapped out and fixed in their minds the night before so they can think it over while they are eating supper and during the evening. To be sure, we are only working eight hours now but that does not make any difference. A good foreman will work out his salvation the night before.

R. C. Henderson:—I think it all comes down to the question that the secretary brought up. They give us the work and it is up to us to place the gang where the men can do the most good

and work to the best advantage. If we have work enough to keep 10 men busy under one foreman in a certain territory, it is the proper thing to use 10 men. I think sometimes we might get a little more work done and more economically by having two gangs with five or six or seven men in a gang, but the chances are, in the majority of cases that one will get more done by having a few men than a large gang.

T. B. Turnbull:—Our railroad is a small railroad and has only a couple of bridge gangs, one or two building gangs and a dock gang; the largest of these gangs comprises seven men including the foreman. If anything heavier than that comes up we have to double them up. The building gang runs as small as four men. The only question, of course, is the overhead expense. Most of these gangs nowadays insist on having a cook. Then if you give a gang of seven men a cook, the gang of four wants a cook also. I was wondering what the rest of the railroads do in the matter of cooks and how large a gang they have before they install a cook.

W. E. Alexander:—We have had many very small crews. I approve of the report that we have before us. We do not want crews too large. The proper size depends on the job we are at. When we are on a large job we want a gang large enough to handle it but on repair work it is a great mistake to have men in each other's way. We want good men and plenty of work for them to get the most done and the best results. We want enough men, however, to do the job in hand. This does not take as many in a crew as people sometimes think.

It has been our custom to have, when we could, what would be called a repair gang of 8 or 10 men including a cook and foreman. From 6 to 8 men besides the cook and foreman makes a very good repair crew for general work. Even less than that on some jobs is better; but when we have less than that we usually send out a few extra men where there is extra work coming up to be done.

The question of cooks has been raised. We have several repair gangs on the road all the time, usually consisting of 5 or 6 men besides the foreman and cook. Then we furnish a good outfit and a good cook. The foundation of a successful crew is a good cook and plenty to eat. The company furnishes the cook and the men furnish the outfit with dishes, clothing, bedding, fuel and a stove, each man paying his share for the food which he eats. They

are charged their board and settle among themselves the amount due from each so the company does not bother about boarding them. Under such conditions we find we can get men better than we could before. Like all other roads our wages are low and we cannot hold good men when somebody else wants them. We had had good bridge men and we lost them. We had good carpenters and we lost them because somebody else could pay them more. We finally got down to where we had only the minimum wage and the minimum ability that went with it. When the wages were raised our efficiency was raised accordingly. However, this has been changed with government management. We are doing better than we had ever done before and our men are working with better heart,—doing more work in the same hours than they did before. We are getting men enough to do our work, but we expect that. We do not have large crews and we do not want them. The greatest trouble with us is to keep our men employed in the winter. We've got to hold our good men then. Sometimes we have extra jobs coming on through the winter and I am glad to be able to keep our men for that. We waste a good deal of time in winter with short days, cold weather, and snow, but we must have some men to keep up the repairs during the winter, so it is more of a problem with us than it is with people further south.

R. H. Reid:—Referring to Mr. Alexander's remarks about taking care of the men in winter I think it is well to provide for the winter work during the summer, to arrange the schedule of work during the season so that the urgent work that must be done in warm weather can be done in the summer and iron work, riveting, etc., can be done in winter as well as in summer.

LABOR SAVING DEVICES

COMMITTEE REPORT

It is a long time since we have heard the old argument that labor saving devices deny the working man his chance of making a living. Even before the present conditions brought about such a scarcity of man power, the value of such devices was fully demonstrated, but there arose frequently the question whether machine or man power was more economical. Today we are facing a situation that is entirely different and the question is almost entirely one of saving labor, or, rather, how can so much work as we have to do be done with the men available?

It has always been a noticeable fact that the more an industry has adopted labor saving devices the more rapidly it has developed, and this development has not been due alone to the devices but also to the planning and organization of the work. The man in charge of the work, whether superintendent, supervisor, foreman, or whatever his title, is the first factor in the problem of saving labor because much depends upon him. It is his part to plan the work so that each operation can be accomplished to the best advantage. Each man is assigned to the work for which he is best fitted and the men are so grouped that the various operations can follow each other systematically and also so as to avoid having men in each other's way or waiting for each other. In planning the work, a foreman should avoid putting too many men on any one part of the work because if they are congested they will not accomplish as much and there will be much idle talking. Men will work best in teams, and if some plan of competition can be instituted, the results will be better. Work should also be planned so that skilled workmen do no unnecessary walking in getting at their tools and materials.

The material arriving at a job should be so unloaded and placed as to avoid unnecessary re-handling. Laborers should be employed to bring the material to convenient places for the skilled workmen. Tools are to be kept in usable and safe condition and returned to proper places at night in tool boxes and tool cars.

The heavier work of the Bridge and Building department is usually quite well provided for, because every railroad has as part of its equipment, pile drivers, locomotives, trains, derricks, and other machinery for doing heavy work. Such equipment is provided as a matter of course. The conditions prevailing during the last few years have brought about an unusual interest in the smaller machines and tools that permit the available force to keep up its maintenance and construction work. No argument is now needed as to the value of such devices, but the question is rather—what can be had and how can it be applied?

The motor car for the transportation of men and material is accomplishing great results. Through its use men are carried to their work with the least expenditure of time and arrive at the job physically ready to go to work. It enables crews to go longer distances from their outfits, and because of this, outfits have to be moved less frequently, thereby saving train service. The push car is loaded with material and hauled as a trailer and material is handled much more expeditiously in this way than in the old manner. It is true there have been some accidents in the use of motor cars, but as the men become more experienced in their use these are less frequent and they may be avoided altogether by the use of proper precautions. Motor cars and push cars should not be used on the main line without knowing that the track is clear. The loading of the cars should be watched carefully by the foreman. Material and tools carelessly loaded may drop off and cause derailments, or con-

siderable loss in time in going back to pick them up. If material is of such a nature that it is necessary to have it project at right angles to the track great care should be exercised in seeing that it will not come in contact with traffic on other tracks or with switch stands, etc.

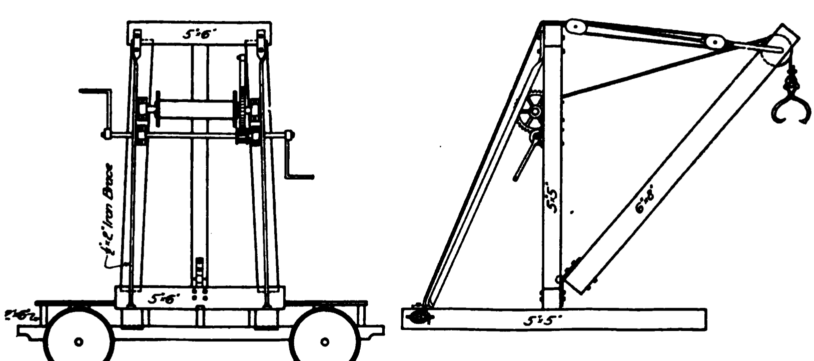
The concrete mixer is another device which has brought about much saving of labor and is now manufactured in so many different sizes and forms that all classes of work can be taken care of. The smaller portable outfits are economical for use on comparatively small pieces of work and the larger outfits, in conjunction with hoists and conveyor belts and other devices, are proving very effective on large construction work.

The gasoline engine is another device that has effected much saving in labor. It is used in conjunction with motor cars and concrete mixers before mentioned, and, in its various forms, can be adapted to many operations on maintenance work, such as running pumping machinery, hoists, small pipe saws, etc.

The manufacturers have placed on the market a variety of tool grinders, with numerous attachments, that make them almost an indispensable part of the working outfit and their value is self-evident.

Hand derricks or cranes can be used most effectively for lifting and placing heavy timbers and other heavy material and have proven themselves very effective when mounted on push cars. The Northern Pacific has in use a home-made hoist mounted on a push car which is very simple of construction and easily manipulated. A frame of 4-in. timbers bolted to the deck of the car carries an old hand car gearing on the gear axle on which has been placed a 10-in. oak drum. Through the frame at right angles to the track and projecting on either side is run a 6-in. by 10-in. timber blocked up on one side of the car and bolted to the floor on the other. Two 6-in. sheaves are fastened at the upper end of the timber and a rail clamp with a chain at the lower end is used to prevent the car from overturning. With this device two men can pick up a stringer from the embankment at the end of the bridge, swing it clear, run it out on the bridge and lower it on the end caps, ready to be put in place. The device has proven very efficient and practical. The Southern Pacific has a light steel derrick mounted on a push car which is used for similar work. The Chicago, Milwaukee & St. Paul Railway has similar home-made devices installed on push cars which will enable two or three men to accomplish work that formerly took from six to eight.

F. E. Weise,
Chairman.

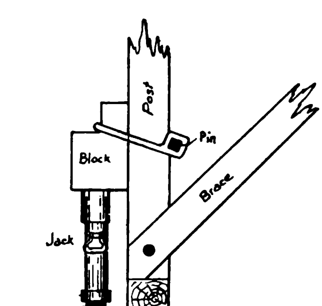


Hand Car Derrick, Chicago, Milwaukee & St. Paul Ry.

Derrick Anchored to the Rail, Loading an 8x16 Stringer, N. Y. N. H. & H. R. R.

Hand Derrick, Labor Saving Devices

Hand Derrick, Labor Saving Devices



Simple Toggle for Jack, B. & O. R. R.

DISCUSSION

E. E. Candee: (by letter) I am using a contrivance on the New York, New Haven & Hartford that would come under this head which consists of a push car with a Jinniwink derrick and a hand crab mounted on its deck for putting in stringers, caps and heavy posts, unloading heavy timber from sideboard cars, setting light structural steel,—and in fact for any purpose where it is desired to lift not over one ton and is not practical to use a steam derrick.

The dimensions of the car and derrick are as follows: wheel base of push car, 8 ft. Deck extends 1 ft. past the forward axle and 2 ft.-6 in. over the rear wheels, making 11 ft.-6 in. over all. Shear legs of the A-frame are 8 ft. long. Boom, 22 ft. long. Crab sets over rear axle.

The car is anchored to the track when in use by rail clamps connected to the body of the car and when thus clamped to the rail the load can be swung out at right angles from the track for a distance equal to the length of the boom. The outfit is taken off the track when not in use by means of a small turntable, or jigger. Three men can place the car on the track ready for service or remove it in one minute. In a test taken when the car was first put in service, it was put on the rails and four 8-in. by 16-in. by 24-ft. stringers were loaded in 4 minutes. The outfit with its load of stringers was pushed out on the bridge, the 4 new stringers placed and the old stringers loaded in 10 minutes. While the track was being lowered the old material was taken on shore and placed on a pile by 3 men and a foreman (with one man lowering the track) the outfit being removed from the track in 6 minutes, making a total of 20 minutes to place 4 stringers on the bridge with the foreman and 4 men doing the work. No man did any lifting or straining as would have been the case if stringers were put in the old way.

The derricks that I have in use were built by my bridge men on days when the weather would not permit them to do outside work. I do not think too much can be said in favor of these little derricks for bridge work; for they not only make it possible to do heavy bridge work easily, but quicker and with fewer men. With this outfit 6 men can do more work in less time than 8 men can do without. We operate them on a trestle where 18 passenger trains pass between 7 a. m. and 6 p. m., besides a large number of freight trains and switching movements and never have to hold an extra over 10 minutes. If the same work was done by hand it would be almost impossible to do it without holding trains one-half hour or more.

FACTORY-MADE REINFORCED-CONCRETE PRODUCTS*

By Charles Gilman

The purpose of this paper is to describe the salient features of reinforced-concrete products as applied to railway work, with special reference to those that are made in a well-organized and equipped plant and which, for the sake of brevity, will be styled "factory-made." It is also proposed to show how the development of the factory-made reinforced-concrete product has solved many of the construction, maintenance and economic problems of railway engineering. The merits that determine the adaptability and efficiency of any construction method from the point of view of a railway engineer, and that are distinctly characteristic of the factory-made concrete product, are the following: Permanency as regards both dependability of service and lasting qualities; availability of products to point of installation; portability of products to facilitate transportation and handling; minimum interference with traffic; reduction in the use of motive power and rolling stock for construction purposes; minimum amount of labor used in the field; ultimate economy.

Concrete Pile Trestles

The first example of factory-made reinforced-concrete products to be considered is the concrete-pile trestle, the development of which began about 1906 by the late C. H. Cartlidge, who was for many years engineer of bridges of the Chicago, Burlington & Quincy R. R., and who is considered the pioneer in the use of factory-made concrete piles and slabs in railway work. In a report on "Reinforced-Concrete Trestles," presented before the Western Society of Engineers, April, 1910, Mr. Cartlidge summed up the results to be attained in the following words: "An investigation of the reasons for the great economy of such a construction as the pile trestle shows that it is largely due to the small amount of work necessary to be done in the field. There are no coffer-dams, foundation pits or falsework to be built. Very little raw material has to be unloaded and cared for. The members composing both the substructure and the superstructure are taken out and put in place very largely by machinery with a minimum disturbance of track and delay to traffic. It was evident that if a construction of permanent material having the characteristics mentioned could be devised, the result would be what was wanted."

To meet with the conditions mentioned by Mr. Cartlidge, it is necessary to obtain the maximum efficiency of concrete and steel so as to reduce the weight to a minimum. The reduction of weight is brought about in the design of concrete piles by providing definitely designated points at which the hitches for handling are to be made. The reinforcement can be increased at these points to take care of the stresses developed in handling, rendering it unnecessary to provide for a cantilever action for the entire pile when handled promiscuously. It has been found that piling 50 ft. in length can be economically designed to be handled with one hitch made one-third the way from the butt end; for longer piles, additional hitches should be provided for. The drawing shown (Fig. 3) indicates the general dimensions and system of reinforcement that has been found to produce a very economic type of piling for railway trestles. This pile is calculated to take a working load of 25 tons with a maximum column action above ground of 20 ft.

The concrete slab, details of which are shown in the illustration, (Fig. 4) should be designed to provide for easy handling. Two slabs are used for one panel of a single track bridge, as they can be placed

*Reprint from American Concrete Institute, Vol. 14, 1918.

Fig. 1.—View in Yard Where Concrete Piles Are Being Made

with less interference to track and traffic and less derrick power than one slab for the entire width of the bridge. A trestle for one track is from 13 ft. to 15 ft. wide, according to the various railway standards, so that each slab would be 6 ft. 6 in. to 7 ft. 6 in. wide. The length of slab can be standardized to a large extent and still make an economical span. It has been found in practice that spans 14 ft. to 16 ft. from center to center of bents produce the most economic structure for trestles of average height. Lifting stirrups are used for handling and are placed so as to balance the slab transversely. Auxiliary reinforcment is placed in the region of the stirrups to carry the stress that is transferred to the upper surface.

The compact organization of a centralized permanent plant that is possible under the factory-made method renders it practical to make up large quantities of piles and slabs ready for use when needed. When a bridge is up for renewal, the length of piling required can be determined either from the record of piling already driven in former structures, with

Fig. 2.—Type of Trestle Built from Factory-Made Units

due regard for the difference in the sectional area of these piles and concrete piles, or by the use of test piles. The usual procedure in the construction of a trestle is to send to the site of the work a pile-driver, generally of the derrick type, with the piling required. This type of driver can be sent either in a work train or in a revenue train, and, having self-propelling facilities, can unload piling, release cars and do the driving without requiring a work train to handle it. As it is usually the custom to work from the old structure that is to be replaced, this driving can be done with the least interference with traffic and without slow orders. After the piling is driven, a small masonry gang casts the caps in place. When the caps have seasoned sufficiently, the slabs are unloaded and set with the derrick. The placing of ballast, the substitution of track ties for bridge ties and the clearing up of the site by the derrick complete the entire construction of the bridge. By comparing this method with the handling of large quantities of raw material, labor, camp equipment,

construction equipment and changes in the old structure, or the construction of falsework and the maintaining of slow orders, with the resulting delay to traffic, it can be readily seen that from a railway point of view the factory-made method as applied in this case permits the construction of a fireproof trestle of maximum permanency and ultimate economy.

Culvert Pipe

All railway officials owe a great debt of gratitude to Mr. Cartlidge, not only because of the concrete pile trestle, but also, and to a greater degree, because of the adaptation of reinforced-concrete pipe to railway requirements. In 1906, Mr. Cartlidge was confronted with the necessity of replacing many of the original wooden box culverts on the C. B. & Q. R. R. After making a considerable study of the materials available and their relative cost, he decided on the factory-made concrete pipe. In casting about for a design which would be economical and safe as well as distinctive he came across the method of reinforcement which provides for a single line placed in the region of tension throughout the pipe. Instead of distorting the reinforcing cage to place it in the region of tension—which is necessary when using this system in a circular pipe—Mr. Cartlidge left it in repose and changed the contour of the pipe section by inserting, between the upper and lower semi-circles of a circular pipe, tangent distances equal to the thickness of the walls of the pipe. This enabled the reinforcement to take the desired position and still be in repose as a circle. In casting the pipe, the ends of the long diameter were marked " Top " indicating that the long diameter was to be placed vertically—the position of maximum strength. This unique design not only produced a pipe of adequate strength and increased flow area, but also afforded an opportunity of proper inspection during and after installation.

In 1907, Prof. A. N. Talbot, of the University of Illinois, made a series of tests on the Cartlidge design of concrete pipe, as well as on cast-iron pipe and other forms of concrete pipe, the results of which were published in Bulletin No. 22 of the University of Illinois. The publication of this report cleared away any uncertainty which existed in the minds of engineers as to the ability of a properly designed and manufactured concrete pipe to successfully carry railway loads and gave the industry the desired impetus.

Since 1906 other designs of concrete pipe have been developed and used on railways. The most common of these is the circular pipe reinforced either with a single line all in the region of tension or two concentric lines. To take care of conditions where a pipe of minimum headroom with adequate area of flow is required, a flat base pipe has been designed, the upper section of which is a semi-circle and the invert a curved surface of large radius. This section has the necessary strength, requires practically no foundation under it, and provides a good flow. A design of triangular section has also been developed and used to some extent for low headroom conditions. While this pipe has considerable strength, and requires a small amount of reinforcement, it is very heavy on account of the thickness of the walls and has a small flow area.

In designing a culvert pipe, due consideration should be given, on account of handling, to the weight per section by properly proportioning and placing the steel in relation to the thickness of the wall. A culvert pipe should have sufficient strength to carry the usual railway loads with a generous factor of safety so that when subjected to unusual or sudden loads it has the ability to resist. Experience has shown that a concrete culvert pipe should have bell and spigot ends, to give the necessary strength and stiffness at the joint to hold the culvert to grade and it should also be of such a length that it can be loaded, unloaded and installed economically.

LENGTH	GROUND LINE TO BUTT.	CLASS 4000.			CLASS 3000			CLASS 2000.			CLASS 1500.			CLASS 1000.		
		d	D.	APPROX. WT.	d	D	APPROX. WT.	d.	D.	APPROX. WT.	d.	D.	APPROX. WT.	d	D.	APPROX. WT.
20'-0"	4'-0"	8¼"	13¼"	1720#	7⅝"	12⅝"	1390#	7"	12"	1180#	6⅜"	11⅜"	1080#	5¾"	10¾"	865#
25'-0"	5'-0"	8¼"	14½"	2440#	7⅝"	13⅞"	1940#	7"	13¼"	1670#	6⅜"	12⅝"	1420#	5¾"	12"	1180#
30'-0"	5'-6"	8¼"	15¾"	3310#	7⅝"	15⅛"	2590#	7"	14½"	2230#	6⅜"	13⅞"	2120#	5¾"	13¼"	1550#
35'-0"	6'-0"	8¼"	17"	4340#	7⅝"	16⅜"	3340#	7"	15¾"	2830#	6⅜"	15⅛"	2770#	5¾"	14½"	1950#
40'-0"	6'-6"	8¼"	18¼"	5550#	7⅝"	17⅝"	4230#	7"	17"	3770#	6⅜"	16⅜"	3530#	5¾"	15¾"	2320#
45'-0"	7'-0"	8¼"	19½"	7450#	7⅝"	18⅞"	5230#	7"	18¼"	4680#	6⅜"	17⅝"	4420#	5¾"	17"	2900#
50'-0"	7'-6"	8¼"	20¾"	8400#	7⅝"	20⅛"	6380#	7"	19½"	5750#	6⅜"	18⅞"	5450#	5¾"	18¼"	3440#
55'-0"	8'-0"	8¼"	22"	10000#	7⅝"	21⅜"	7680#	7"	20¾"	6960#	6⅜"	20⅛"	6590#	5¾"	19½"	4070#
60'-0"	8'-6"	8¼"	23¼"	12400#	7⅝"	22⅝"	8800#	7"	22"	8340#	6⅜"	21⅜"	7750#	5¾"	20¾"	4640#

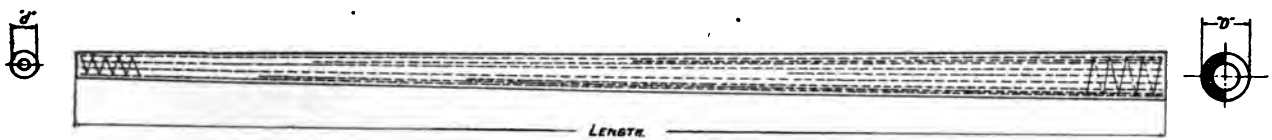


Fig. 5.—Schedule of Concrete Poles Held in Stock

Grade Elimination

G. E. Tebbetts, Bridge Engineer of the Kansas City Terminal, has worked out a very interesting type of factory-made concrete in connection with the numerous subways and highway bridges that were constructed in Kansas City during the past few years. At first, the abutments, pier foundations, piers and girders were cast in place, using slabs built under the factory-made system. It was then considered feasible to make the girders as units and install them later. A further development included the columns. It is therefore possible to see, in Kansas City, subways showing the gradual development of the factory-made concrete until now only the abutments and pier foundations are cast in place.

This type of construction has reduced to a very noticeable degree the interference with both railway and street traffic, the time of construction and the ultimate economy of the entire work, to say nothing of obtaining all the advantages of factory-made concrete that have been discussed elsewhere in this paper. The possibility of inspecting each unit of a structure before it goes into service, with the minimum interference of traffic during erection, has made this type of construction very attractive to railway engineers.

Where streets cross over railways, this same type of unit construction can be used. A design for this particular purpose has been worked out very effectively by A. B. Cohen, Concrete Engineer of the Delaware, Lackawanna & Western Railroad. It is especially effective where the decks of bridges having stone or concrete abutments in good condition require renewal. The use of factory-made beams, girders and hand rails has reduced the field work to a matter of a few hours. Where new foundations for columns or new abutments are necessary, they can be installed without interfering with railway or highway traffic, and the columns, girders and slabs can be set in place by work trains in a surprisingly short time.

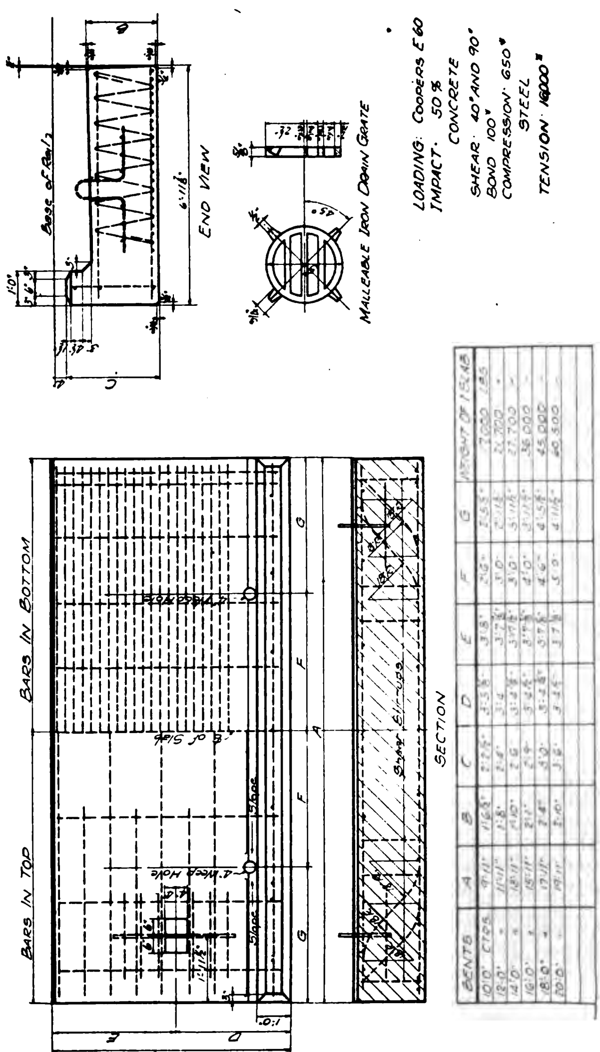
Houses

Railway systems require many small houses that should be fireproof, ratproof, portable, sanitary and reasonably safe against malicious damage. The various types used include telephone booths at passing sidings, watchmen's houses at grade crossings, block stations, oil houses, houses for torpedoes and fuses, outhouses, pump houses, scale houses, motor-car houses, transformer houses and cable-test houses. The factory-made product has fulfilled all of the above requirements at a reasonable cost. With the increased use of the factory-made product, it has been possible to standardize many of the types, justifying the expense of steel forms, the use of which has produced accuracy and economical production. Today, the only limitation of the size of houses that can be made in the factory is determined by railway clearances. Particular attention has been given in the design of these houses to permit handling by derricks or by skids. Usually, the roof and its connection to the side walls are so reinforced that a timber under the ridge pole or at the base of the roof fastened to a line through the ventilator or chimney hole will permit handling with a derrick. In most cases the matter of foundation can be taken care of with a bed of cinders or gravel. Where it is necessary to install heavier foundations, particularly where the ground is soft, or to make up for the inequality in the level of the ground surface, as on the sides of embankments, pedestals can be installed at small expense.

Manholes

The construction of underground conduit work by the telephone, telegraph and signal departments of railways has in many cases been materially benefited by the use of portable concrete manholes. Instead of building expensive brick and concrete work in place, which must be pro-

tected from the vibration of passing trains in order to season properly, it is possible to place the factory-made product with a derrick in holes which are prepared just in advance of the installation. This reduces to a



BENTS	A	B	C	D	E	F	G	WEIGHT OF 1 SLAB
10'0" CTRS	9'11"	1'6 3/4"	2'2 5/8"	3'3 5/8"	3'8"	2'6"	3'5 5/8"	7,000 LBS
12'0" "	11'11"	1'8"	2'4"	3'4"	3'7 5/8"	3'0"	2'11 1/2"	[illegible] "
14'0" "	13'11"	1'10"	2'6"	3'4 5/8"	3'7 5/8"	3'0"	3'11 1/2"	27,700 "
16'0" "	15'11"	2'1"	2'9"	3'4 5/8"	3'7 5/8"	4'0"	3'11 1/2"	36,000 "
18'0" "	17'11"	2'4"	3'0"	3'4 5/8"	3'7 5/8"	4'6"	4'5 1/2"	45,000 "
20'0" "	19'11"	2'10"	3'6"	3'4 5/8"	3'7 5/8"	5'0"	4'11 1/2"	60,500 "

Fig. 4.—Reinforced-Concrete Bridge Slabs

minimum the time necessary to keep excavations adjacent to the track open, and consequently slow orders. The use of the factory-made manhole has produced not only a permanent, waterproof structure, but it has also materially reduced the cost.

Battery Boxes and Wells

The high cost of metal with its tendency to corrode, and the short life and instability of timber, have created a demand for a more stable material for battery boxes, wells and chutes for the signal department of railways. The necessity for a receptacle that is waterproof, frost-proof, portable and of permanent construction, which properly protects storage and primary batteries, has been completely met by the use of the factory-made concrete product, and today this product is a standard on the railways of this country.

Poles

With the decreasing supply of suitable material for wooden poles for telegraph and telephone service, the various railways in the country have been casting about for an adequate substitute. A number of short lines have been constructed with solid reinforced-concrete poles, within the past five years. These, however, have not proven satisfactory on account of their weight and cost. Recently, a machine has been developed by means of which a hollow concrete pole can be produced by centrifugal methods. With this machine a pole can be made of any desired length and taper, and the thickness varied to meet the load conditions. The density produced in the concrete by the pressure of this centrifugal force is remarkable. A pole thus made has sufficient strength to meet storm conditions, is not affected materially by the elements, is light in weight, permitting ease in handling, has a pleasing appearance, and is low in first cost. In addition to the requirements for telegraph and telephone service, these poles can be used on railways for station lighting and signals of all types.

Miscellaneous Products

In the foregoing, an attempt has been made to show the application of those concrete products in general use. Other products in concrete have been used as substitutes for timber, cast iron and steel, such as posts for right-of-way fences, hand rails for viaducts and retaining walls, pipe-carrier foundations for interlocking plants, warning signs, smoke jacks for engine houses, boot tanks for grain elevators, cribbing and crossing planks.

Where the Products Are Made

The first plants for the manufacture of concrete products for railways consisted of a siding, a derrick within range of the siding, a platform around the derrick on which to set up the forms, a mixer within the radius of the derrick so that it could fill the forms, an industrial track on which was operated a car to transport the green product to the adjacent seasoning yard, a cement house, and cage shed. No attempt was made to operate these early plants during the winter, the plan being to manufacture as much product during the warm and fair weather as possible and shut down for the winter. The output of such a plant was further limited to the speed of the derrick which was used to unload raw material, set up and strip the forms, pour the concrete into them, and load the finished product.

As the demand for the factory-made product increased, it was found necessary to operate part of the winter, at least, on days when the weather was favorable. For the manufacture of pipe this was made possible by the introduction of small steam rooms within the radius of the derrick. These rooms were large enough to hold a number of pipes and had removable roofs so arranged that they could be handled easily with the derrick. It was customary to build these houses in groups of three, so that only one at a time was open each day for casting, while the other two contained pipe seasoning under steam. In the case of battery wells, boxes and houses, a separate building was erected for their manufacture. This

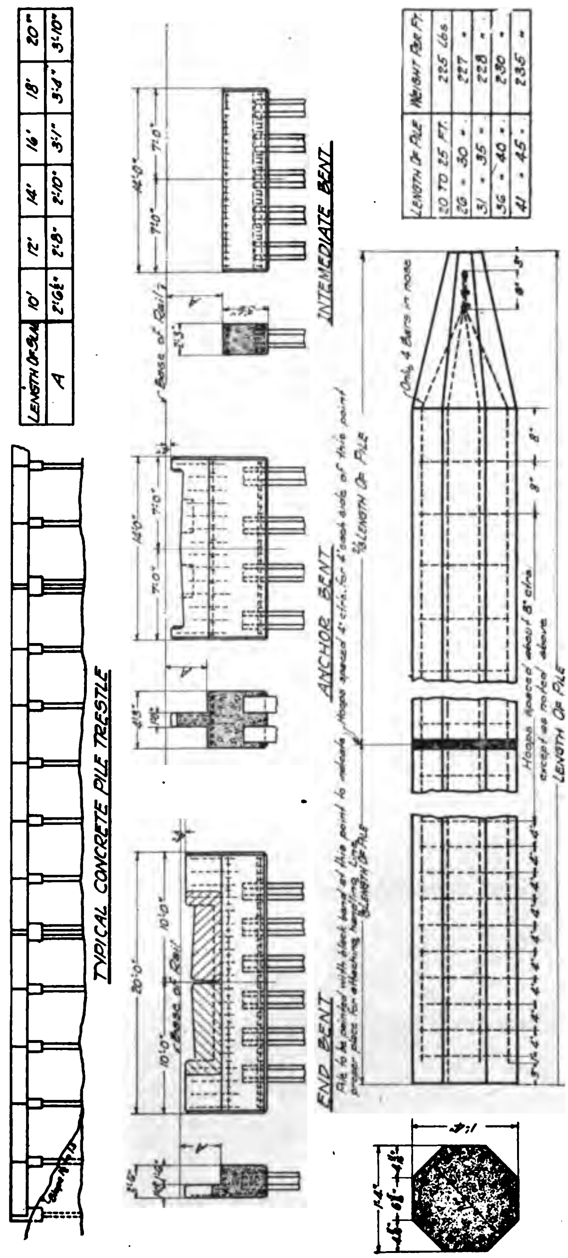
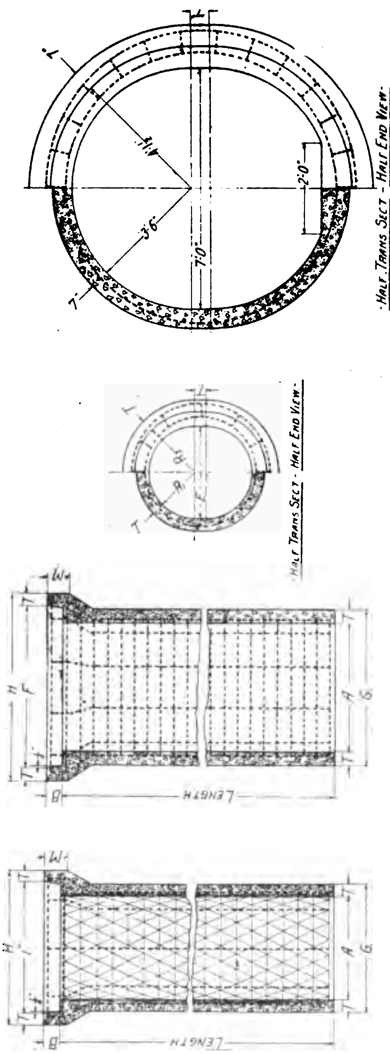


Fig. 3.—Piles and Trestle Bent for Standard Construction

was usually a one-story structure, with a concrete floor and some means of heating. As these products can be handled with a large horse on wheels, this building was placed beyond the range of the derrick but near enough so that the finished product when wheeled outside the building could be loaded out by the derrick.



E	A	G	F	H	T	M	B	R_1	R_2	Water Area Square Feet	% Excess Water Area over Round	Length of Pipe	Weight Per Lin Ft Pounds
18"	20½"	2'-1½"	2'-2½"	2'-7¼"	2½"	6"	4"	0'-9"	1'-0"	2.08	17.6	8'-0"	190
20"	22¾"	2'-4½"	2'-5¼"	2'-10¾"	2¾"	6"	4"	0'-10"	1'-1½"	2.56	16.9	8'-0"	233
24"	27"	2'-9"	2'-10"	3'-4"	3"	6"	4"	1'-0"	1'-3½"	3.64	15.5	8'-0"	300
30"	33½"	3'-4½"	3'-5½"	4'-0½"	3½"	6"	4"	1'-3"	1'-7"	5.64	14.9	8'-0"	435
36"	40"	4'-0"	4'-1"	4'-9"	4"	6"	4"	1'-6"	1'-10½"	8.06	14.0	8'-0"	590
42"	46"	4'-6"	4'-7"	5'-3"	4"	6"	4"	1'-9"	2'-1½"	10.71	11.3	8'-0"	675
48"	52½"	5'-0½"	5'-1½"	5'-10½"	4½"	6"	4"	2'-0"	2'-4½"	13.97	11.1	8'-0"	815
54"	59"	5'-9"	5'-10"	6'-8"	5"	8"	5"	2'-3"	2'-8½"	17.78	11.8	6'-0"	1075
60"	65"	6'-3"	6'-4"	7'-2"	5"	8"	5"	2'-6"	2'-11½"	21.72	10.6	6'-0"	1200
68"	74"	7'-2"	7'-3"	8'-3	6"	8"	6"	2'-10"	3'-4½"	28.05	.004	6'-0"	1700
84"	89½"	8'-9"	8'-10"	10'-0"	7"	8"	7"	3'-6"	4'-1½"	42.64	10.6	6'-0"	2445

Fig. 6.—Standard Sizes of Reinforced-Concrete Railway Culvert Pipe

With the further development of the industry, it became necessary to design a plant for continuous operation and large capacity. Today, a modern plant for the manufacture of concrete pipe consists of a long one-story building equipped at one end with an elevated hopper for sand and

Fig. 7.—Lifting Precast Railway House

Fig. 8.—Concrete Pipe in Stock Yard Awaiting Distribution

gravel, filled with a derrick and clam-shell bucket. The mixer is also elevated and is placed directly under the gates of the hopper so that the operator can control the flow of sand and gravel easily and quickly. The house is equipped with a number of parallel tracks with two transfers—one in the rear and one directly in front of the mixer. The forms are set up on platform cars which are pushed up to the mixer, filled, and then pushed down another track to the steam room. In the middle of the house is a stripping tower equipped with electric hoists and chain blocks for stripping and setting up the forms. In the rear of the plant is a derrick for removing the pipe from the cars to the seasoning yard. The cement storage room and the cage room are located inside the main building. Such a plant can run 24 hours a day throughout the year and has a large production.

In addition to the pipe house, a modern plant has a building for the

Fig. 9.—Type of Large Precast House

manufacture of wells, boxes, manholes, houses, posts and smaller products. It also has a pile yard for the manufacture of concrete piles and slabs, which is usually a level strip of ground adjacent to a piece of straight side track. The equipment necessary for manufacture of piles and slabs consists of a mixing plant, forms—preferably of steel, foundation timbers and pallets to support the forms and a locomotive crane for setting forms, casting, and loading the seasoned piles and slabs. For the manufacture of the hollow concrete poles a separate building is required with a mixing plant and an overhead crane for handling the raw material and the finished product. From the foregoing it is seen that the present tendency in plant construction is to obtain uninterrupted production and protect the product and the labor from the elements which results in more and better product.

In conclusion, the foregoing may be summed up as follows: With the use of the factory-made reinforced-concrete products, the uncertainties of

Summary

other methods of construction can be eliminated and the amount of labor, equipment and transportation greatly reduced. The delays due to weather conditions, dependency on migratory labor and the necessity of maintaining traffic, regardless of construction economies, are largely eliminated. The centralized and thoroughly trained organization of the factory permits a thoroughness of inspection during all stages of production that prevents, as far as possible, a failure after installation. The work in the factory can progress continuously without regard to climatic or other conditions, making it possible to carry a stock of finished, seasoned product at all times. By taking the finished product from stock, a definite program for installation can be arranged and carried out. The thoroughness of workmanship that is possible in the factory results in a quality of

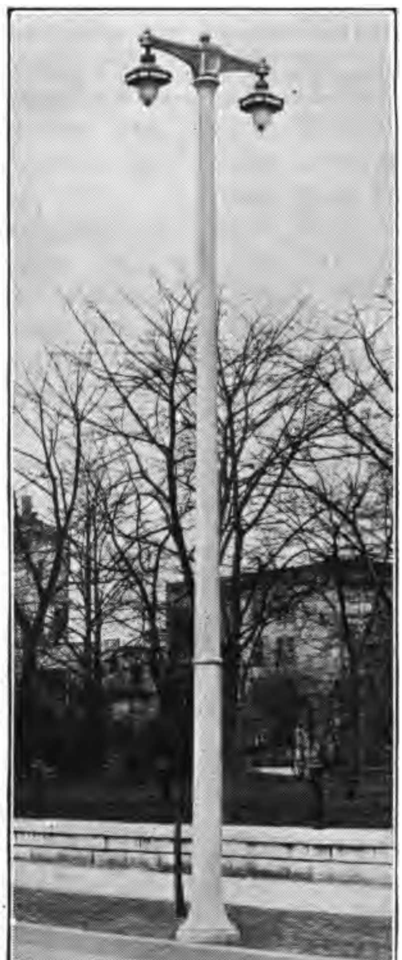


Fig. 10.—Hollow Concrete Lighting Standard

concrete that can be depended upon to meet designing requirements with a maximum degree of certainty. The great density of concrete, when properly proportioned, mixed and thoroughly seasoned, such as produced under factory methods, permits the use of higher stresses than ordinarily assumed.

It is often necessary to use large factors of safety or low stresses to guard against the possibility of poor concrete in certain classes of field work, due to the prevalent use of local material, an unreliable supply of water as regards its purity and the inability to maintain thorough inspection. These conditions of course do not hold true on field work in general, but they can be eliminated more completely by the factory system than by any other. The high grade of concrete obtained by the factory methods justifies the use of a higher percentage of reinforcement with a result that sectional areas can be greatly reduced. Experience has shown that it is economically feasible to eliminate cast iron, steel, timber and other material subject to deterioration from many construction projects where formerly these materials were considered indispensable.

Today the use of the concrete product in preference to these other materials is of most importance in that the ingredients of the concrete product and the labor necessary to produce it do not interfere with the production of war materials.

Note: This Association received the title—American Railway Bridge and Building Association—at the 18th annual convention at Washington, D. C., October, 1908. Prior to that time it was called —Association of Railway Superintendents of Bridges and Buildings.

LIST OF ANNUAL CONVENTIONS.

No.	Place.	Date.	Membership.
1	St. Louis, Mo.,	Sept. 25, 1891	60
2	Cincinnati, Ohio,	Oct. 18-19, 1892	112
3	Philadelphia, Pa.,	Oct. 17-19, 1893	128
4	Kansas City, Mo.,	Oct. 16-18, 1894	115
5	New Orleans, La.,	Oct. 15-16, 1895	122
6	Chicago, Ill.,	Oct. 20-22, 1896	140
7	Denver, Colo.,	Oct. 19-21, 1897	127
8	Richmond, Va.,	Oct. 18-19, 1898	148
9	Detroit, Mich.,	Oct. 17-18, 1899	148
10	St. Louis, Mo.,	Oct. 16-18, 1900	143
11	Atlanta, Ga.,	Oct. 15-17, 1901	171
12	Minneapolis, Minn.,	Oct. 21-23, 1902	195
13	Quebec, Canada,	Oct. 20-22, 1903	223
14	Chicago, Ill.,	Oct. 18-20, 1904	293
15	Pittsburg, Pa.,	Oct. 17-19, 1905	313
16	Boston, Mass.,	Oct. 16-18, 1906	340
17	Milwaukee, Wis.,	Oct. 15-17, 1907	341
18	Washington, D. C.,	Oct. 20-22, 1908	368
19	Jacksonville, Fla.,	Oct. 19-21, 1909	393
20	Denver, Colo.,	Oct. 18-20, 1910	428
21	St. Louis, Mo.,	Oct. 17-19, 1911	499
22	Baltimore, Md.,	Oct. 15-17, 1912	524
23	Montreal, Que.,	Oct. 21-23, 1913	570
24	Los Angeles, Cal.,	Oct. 20-22, 1914	586
25	Detroit, Mich.,	Oct. 19-21, 1915	665
26	New Orleans, La.,	Oct. 17-19, 1916	710
27	Chicago, Ill.,	Oct. 16-18, 1917	704
28	Chicago, Ill.,	Oct. 15-17, 1918	716

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Secretary	**S. F. Patterson**	**S. F. Patterson**	**S. F. Patterson**	**S. F. Patterson.**
Treasurer	**C. P. Austin**	**C. P. Austin**	**C. P. Austin**	**C. P. Austin.**
Executive Members	**R. H. Reid**	**W. O. Eggleston**	**H. Rettinghouse**	**W. O. Eggleston**
	W. O. Eggleston	**A. E. Killam**	**A. E. Killam**	**A. E. Killam.**
	A. E. Killam	**H. Rettinghouse.**	**J. S. Lemond**	**J. S. Lemond.**
	R. C. Sattley	**J. S. Lemond**	**C. W. Richey**	**C. W. Richey.**
	H. Rettinghouse	**W. H. Finley**	**H. H. Eggleston.**	**H. H. Eggleston**
	J. S. Lemond	**C. W. Richey**	**F. E. Schall**	**B. J. Sweatt.**

	1907-1908.	1908-1909.	1909-1910.	1910-1911.
President	R. H. Reid	J. P. Canty	J. S. Lemond	H. Rettinghouse
1st. V.-Pres.	J. P. Canty	H. Rettinghouse	H. Rettinghouse	F. E. Schall
2nd. V.-Pres.	H. Rettinghouse	F. E. Schall	F. E. Schall	A. E. Killam
3rd. V.-Pres.	F. E. Schall	J. S. Lemond	A. E. Killam	J. N. Penwell
4th. V.-Pres.	W. O. Eggleston	A. E. Killam	J. N. Penwell	L. D. Hadwen
Secretary	S. F. Patterson	S. F. Patterson	C. A. Lichty	C. A. Lichty
Treasurer	C. P. Austin	C. P. Austin	J. P. Canty	J. P. Canty
Executive Members	A. E. Killam	J. N. Penwell	W. Beahan	T. J. Fullem
	J. S Lemond	Willard Beahan	F. B. Scheetz	G. Aldrich
	C. W. Richey	F. B. Scheetz	L. D. Hadwen	P. Swenson
	T. S. Leake	W. H. Finley	T. J. Fullem	G. W. Rear
	W. H. Finley	L. D. Hadwen	G. Aldrich	W. O. Eggleston
	J. N. Penwell	T. J. Fullem	P. Swenson	W. F. Steffens

	1911-1912.	1912-1913.	1913-1914.	1914-1915.
President	F. E. Schall	A. E. Killam	J. N. Penwell	L. D. Hadwen
1st. V.-Pres.	A. E. Killam	J. N. Penwell	L. D. Hadwen	G. Aldrich
2nd. V.-Pres.	J. N. Penwell	L. D. Hadwen	G. Aldrich	G. W. Rear
3rd. V.-Pres.	L. D. Hadwen	T. J. Fullem	G. W. Rear	C. E. Smith
4th. V.-Pres.	T. J. Fullem	G. Aldrich	C. E. Smith	E. B. Ashby
Secretary	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Treasurer	J. P. Canty	J. P. Canty	J. P. Canty	F. E. Weise
Executive Members	G. Aldrich	G. W. Rear	W. F. Steffens	W. F. Steffens
	P. Swenson	W. F. Steffens	E. B. Ashby	S. C. Tanner
	G. W. Rear	E. B. Ashby	S. C. Tanner	Lee Jutton
	W. F. Steffens	C. E. Smith	Lee Jutton	W. F. Strouse
	E. B. Ashby	S. C. Tanner	W. F. Strouse	C. R. Knowles
	W. O. Eggleston	Lee Jutton	C. R. Knowles	A. Ridgway

	1915-1916	1916-1917	1917-1918	1918-1919
President	G. W. Rear	C. E. Smith	S. C. Tanner	Lee Jutton
1st. V.-Pres.	C. E. Smith	E. B. Ashby	Lee Jutton	F. E. Weise
2nd V.-Pres.	E. B. Ashby	S. C. Tanner	F. E. Weise	W. F. Strouse
3rd V.-Pres.	S. C. Tanner	Lee Jutton	W. F. Strouse	C. R. Knowles
4th V.-Pres.	Lee Jutton	F. E. Weise	C. R. Knowles	A. Ridgway
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Executive Members	F. E. Weise	W. F. Strouse	A. Ridgway	J. S. Robinson
	W. F. Strouse	C. R. Knowles	J. S. Robinson	J. P. Wood
	C. R. Knowles	A. Ridgway	J. P. Wood	A. B. McVay
	A. Ridgway	J. S. Robinson	D. C. Zook	J. H. Johnston
	J. S. Robinson	J. P. Wood	A. B. McVay	E. T. Howson
	J. P. Wood	D. C. Zook	J. H. Johnston	C. W. Wright

CONSTITUTION *

ARTICLE I.

NAME.

SECTION 1. This association shall be known as the American Railway Bridge & Building Association.

ARTICLE II.

OBJECT.

SECTION 1. The object of this association shall be the advancement of knowledge pertaining to the design, construction and maintenance of railway bridges, buildings and other structures, by investigation, reports and discussions, providing a medium for the exchange of ideas to the end that bridge and building practice may be systematized and improved.

SECTION 2. The association shall neither indorse nor recommend any particular devices, trade marks or materials, nor will it be responsible for any opinions expressed in papers, reports or discussions unless the same have received the endorsement of the association in regular session.

ARTICLE III.

MEMBERSHIP.

SECTION 1. The membership of this association shall be divided into two classes—active and life members.

SECTION 2. To be eligible for active membership, a person must be actively employed in railway service in responsible charge of the design, construction or maintenance of railway bridges, buildings or other structures; a professor of engineering in a college or university of recognized standing; an engineering editor, or a government or private timber expert.

SECTION 3. To be eligible for life membership a person must have been a member of the association for at least five years and in general must have retired from active railway service. The association, however, may waive the latter condition by a majority vote of the members at a regular session for good and sufficient reasons. A life member shall have all the privileges of active membership and shall not be required to pay annual dues.

SECTION 4. Any member guilty of conduct unbecoming a railroad officer and a member of this association, or who shall refuse to comply with the rules of this association, may forfeit his membership on a two-thirds vote of the members present at any regular session of the association.

SECTION 5. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled, or dropped for non-payment of dues in accordance with Section 1 of Article VII.

* Revised October, 1914. Amended October, 1915.

ARTICLE IV.

OFFICERS.

SECTION 1. The officers of this association shall be a president, four vice-presidents, a secretary-treasurer and six executive members, all of whom shall constitute the executive committee.

SECTION 2. The past presidents of this association who continue to be members shall be entitled to be present at all meetings of the executive committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past presidents shall not have a right to vote, nor shall their presence be requisite in order to constitute a quorum.

SECTION 3. Vacancies in any office for the unexpired term shall be filled by the executive committee without delay.

ARTICLE V.

EXECUTIVE COMMITTEE.

SECTION 1. The executive committee shall exercise a general supervision over the financial interests of the association, assess the amount of annual and other dues, call, prepare for and conduct general or special meetings and make all necessary purchases and contracts required to conduct the general business of the association, but shall not have the power to render the association liable for any debt beyond the amount then in the treasury not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the association.

SECTION 2. Two-thirds of the members of the executive committee may call special meetings, thirty days' notice being given members by mail.

SECTION 3. Five members of the executive committee shall constitute a quorum for the transaction of business.

ARTICLE VI.

ELECTION OF OFFICERS AND TENURE OF OFFICE.

SECTION 1. Except as otherwise provided the officers shall be elected at the regular annual meeting of the association which convenes on the third Tuesday in October, and the election shall not be postponed except by unanimous consent of the members present at said annual meeting. The election shall be by ballot, a majority of the votes cast being required for election. Any active member of the association not in arrears for dues shall be eligible for office, but the president shall not be eligible for reëlection.

SECTION 2. The president, four vice-presidents and secretary-treasurer shall hold office for one year and the executive members for two years, three being elected each year. All officers will retain their offices until their successors are elected and installed.

SECTION 3. The term of office of the secretary-treasurer may be terminated at any time by a two-thirds vote of the executive committee. His compensation shall be fixed by a majority vote of the executive committee. The secretary-treasurer shall also serve as secretary of the executive committee.

SECTION 4. The secretary-treasurer shall be required to give bond in an amount to be fixed by the majority of the executive committee.

ARTICLE VII.

ANNUAL DUES.

SECTION 1. Every member upon joining the association shall pay to the secretary-treasurer three dollars membership fee and two dollars per year in advance for annual dues. No member one year in arrears for dues shall be entitled to vote at any election, and any member more than one year in arrears shall be stricken from the list of members at the discretion of the executive committee.

ARTICLE VIII.

AMENDMENTS.

SECTION 1. This constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that notice of the proposed amendment or amendments has been sent to the members at least sixty days previous to said regular meeting.

BY-LAWS*

TIME OF MEETING.

1. The regular meeting of this association shall convene annually on the third Tuesday in October at 10 a. m.

PLACE OF MEETING.

2. Places of holding the next annual convention may be proposed at any regular session of the association. All the places proposed shall be submitted to a ballot vote of the members present at the annual business session and the place receiving a majority of all votes cast shall be declared the location of the next annual meeting. If no place receives a majority of the votes cast, the place receiving the lowest number of votes shall be dropped on each subsequent ballot until a place is chosen.

3. It shall lie within the power of the executive committee to change the location of the meeting place if it becomes apparent that it is for the best interests of the association.

QUORUM.

4. At the regular meeting of the association, fifteen or more members shall constitute a quorum.

DUTIES OF OFFICERS.

5. The president shall have general supervision over the affairs of the association. He shall preside at all meetings of the association and of the executive committee; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. He shall,

* Revised October, 1914. Amended October, 1915.

with the secretary-treasurer, sign all contracts or other written obligations of the association which have been approved by the executive committee. At the annual meetting the president shall present a report containing a statement of the general condition of the association.

6. The vice-presidents in order of seniority shall preside at meetings in the absence of the president and discharge his duties in case of a vacancy in his office.

7. It shall be the duty of the secretary-treasurer to keep a correct record of proceedings of all meetings of this association; to keep correct all accounts between this association and its members; to collect all moneys due the association, and deposit the same in the name of the association. He shall invest all funds not needed for current disbursements as shall be ordered by the executive committee. He shall pay all bills, when properly certified and approved by the president, and make such reports as may be called for by the executive committee. He shall also perform such other duties as the association may require.

NOMINATING COMMITTEE.

8. After each annual meeting the president shall appoint a committee of five members, not officers of the association, of whom two at least shall be past presidents, and two of whom shall have served on the committee the previous year, which shall prepare a list of names of nominees for officers to be voted on at the next annual convention, in accordance with Article VI of the constitution, said list to be read at the first session of the second day of said convention. Nothing in this section shall be construed to prevent any member making further nominations.

AUDITING COMMITTEE.

9. At the first session of each annual meeting the president shall appoint a committee of three members, not officers of the association, whose duty it shall be to examine the accounts and vouchers of the secretary-treasurer and certify as to the correctness of his accounts. Acceptance of this committee's report will be regarded as the discharge of the committee.

COMMITTEE ON SUBJECTS FOR DISCUSSION.

10. After the annual meeting the president shall appoint a committee whose duty it shall be to prepare a list of subjects for investigation to be submitted for approval at the next convention.

COMMITTEES ON INVESTIGATION.

11. After the association has adopted the list of subjects for investigation the president for the succeeding year shall appoint the committees who shall prepare the subjects for report and discussion. He may also appoint individual members to prepare reports on special subjects, or to report on any special or particular subject.

PUBLICATION COMMITTEE.

12. After each annual meeting the executive committee shall appoint a publication committee consisting of three active members whose duty it shall be to coöperate with the secretary in the issuing of the publications of the association. The assignment of this committee shall be such that at least one member shall have served on the committee during the previous year.

ORDER OF BUSINESS.

13. 1st—Registration of members.
2nd—Reading minutes of the last meeting.
3rd—Admission of new members.
4th—President's address.
5th—Report of secretary-treasurer.
6th—Payment of annual dues.
7th—Appointment of special committees.
8th—Reports of standing committees.
9th—Unfinished business.
10th—New business.
11th—Election of officers and selection of place for holding next annual meeting.
12th—Installation of officers.
13th—Adjournment.

(Report of nominating committee to be read at first session of second day—Section 9 of By-Laws.)

DECISIONS.

14. The votes of a majority of the members present shall decide any question, motion or resolution which shall be brought before the association, unless otherwise provided.

DISCUSSIONS.

15. All discussions shall be governed by Robert's rules of order.

DIRECTORY OF MEMBERS

Aagaard, P., Chief Inspector, I. C. R. R., Chicago.
Ailes, N. C., Asst. Val. Engr., D. & H. Co., Albany, N. Y.
Airmet, E. S., For. Ptr., O. S. L. R. R., Salt Lake City.
Alexander, S. Y., G. F. B. & B., St. L. B. & M. Ry., Kingsville, Tex.
Alexander, W. E., Supt. B. and B., B. & A. R. R., Houlton, Me.
Allard, E. E., For. B. & B., Mo. Pac. Ry., St. Louis.
Allen, T. H., Supv. B. & B., C. & O. Ry., Hinton, W. Va.
*Althof, L. W.
Anderson, August, Gen'l For. B. and B., L. S. & I. Ry., Marquette, Mich.
Anderson, L. J., Supv. B. and B., C. & N. W. Ry., Escanaba, Mich.
Andrews, G. W., Asst. to Eng. M. of W., B. & O. R. R., Baltimore, Md.
Andrews, T. O., L. E. & W. R. R., Tipton, Ind.
Archbold, H. L., Div. Engr., Sou. Pac. Co., Tucson, Ariz.
Arey, R. J., 541 So. Cummings St., Los Angeles, Cal.
Ashby, E. B., Consulting Engr., L. V. R. R., New York City.
Ashmore, A. B., Supv. B. & B., M. L. & T. Co., Lafayette, La.
Ashton, D. H., Asst. Engr., O. S. L. R. R., Pocatello, Idaho.
Auge, E. J., Chief Carp., C. M. & St. P. Ry., Wells, Minn.
Austin, C. P., 107 Park St., Medford, Mass.

Bach, C. F., Supv. B. & B., C. & N. W. Ry., Belle Plaine, Iowa.
Bailey, F. W., Supt. M. of W., S. A. & A. P. Ry., Yoakum, Tex.
Bailey, S. D., 633 Hubbard Ave., Detroit, Mich.
Bainbridge, C. N., Engr. Design, C. M. & St. P. Ry., Chicago.
Ball, E. E., Div. Engr., A. T. & S. F. Ry., Fresno, Cal.
Ballard, C. F., Carp. For., S. A. L. Ry., Peachland, N. C.
Baluss, F. C., Engr. B. & B., D. M. & N. Ry., Duluth, Minn.
*Barber, N. N.,
Barger, T. R., For. B. & B., L. & N. W. R. R., Homer, La.
Barnes, O. F., Div. Engr., Erie R. R., Jersey City, N. J.
Barrett, E. K., Supvr. B. and B., F. E. C. Ry., St. Augustine, Fla.
Barrett, J. E., Supt. of Track, B. and B., L. & H. R. Ry., Warwick, N. Y.
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Barton, M. M., 311 No. 34th St., Philadelphia, Pa.
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Beal, F. D., 800 Fife Bldg., San Francisco, Cal.
Beard, A. H., 705 No. 11th St., Reading, Pa.
Beeler, C. L., Asst. Engr., N. Y. N. H. & H. R. R., New Haven, Conn.
Beeson, R. W., Mast. Carp., C. & S. Ry., Trinidad, Colo.
Bender, Henry, Supv. B. & B., C. & N. W. Ry., Eagle Grove, Ia.
Bennett, D. E., For. B. & B., Mo. Pac. R. R., DeSoto, Mo.
Benz, F. A., Div. Engr., B. R. & P. Ry., E. Salamanca, N. Y.
Berry, J. S., Supt. B. and B., S. L. S. W. Ry., Tyler, Tex.
Bibb, J. M., Supvr. B. and B., L. & N. R. R., Birmingham, Ala.
Bigelow, F. M., Supv. B. & B., L. A. & S. L. R. R., Salt Lake City.
Bishop, McClellan, Mast. Carp., C. R. I. & P. Ry., El Reno, Okla
Bishop, R. R., For. B. and B., L. A. & S. L. R. R., Salt Lake City.
Black, G. W., Supt. McGrath Sand & Gravel Co., Pekin, Ill.
Black, J. D., Supvr. B. and B., P. M. R. R., Saginaw, Mich.

*In the National Service.

Blake, L. M., Supv. B. & B., B. & M. R. R., St. Johnsbury, Vt.
Blowers, S. H., For. Carp., B. & O. R. R., Columbus, O.
Bock, J. G., Gen. Br. Insp., C. St. P. M. & O. Ry., St. Paul, Minn.
Bohland, J. A., Br. Engr., G. N. Ry., St. Paul, Minn.
Bonner, J. K., Asst. Supvr. B. & B., N. Y. C. R. R., Rochester, N. Y.
Bourgeois, F. J., Supv. B. & B., N. O. G. N. R. R., Bogalusa, La.
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Bowers, Stanton, Bradford, O.
Bowers, S. C., Mast. Carp. of Brdgs., P. C. C. & St. L. Ry., Steubenville, O.
Bowman, R. M., Pur. Agt., Lackawanna Bridge Co., Buffalo, N. Y.
Boyd, G. E., Div. Engr., D. L. & W. R. R., Buffalo, N. Y.
Boyer, Grant, Div. For. B. & B., M. C. R. R., Detroit, Mich.
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Browne, J. S., Asst. Engr., N. Y. N. H. & H. R. R., New Haven, Conn.
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Burgess, W. H., Supvr. B. & B., Sou. Pac. Co., Stockton, Cal.
Burke, Daniel, Supvr. B. and B., Sou. Pac. Co., Tucson, Ariz.
Burnett, W. L., For. B. & B., St. L. I. M. & S. Ry., Eudora, Ark.
Burns, W. E., Asst. Eng., S. P. Co., San Francisco (care of G. W. Rear).
Burpee, Moses, Chief Engr., B. & A. R. R., Houlton, Maine.
Burrell, F. L., Supv. B. and B., C. & N. W. Ry., Fremont, Neb.
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Byrd, J. E., Asst. For. B. & B., St. L. I. M. & S. Ry., McGehee, Ark.
Byrd, W. E., Asst. For. B. & B., St. L. I. M. & S. Ry., McGehee, Ark.

Caldwell, C. H., For. B. & B., Sou. Pac. Co., E. Bakersfield, Cal.
Caldwell, J. M., Insp. B. and B., C. I. & L. Ry., Lafayette, Ind.
Caldwell, J. T., For. B. & B., Sou. Pac. Co., Bakersfield, Cal.
Camp, W. M., Editor, Railway Review, Chicago, Ill.
Candee, Eldridge E., Sup B & B, N Y N H &HRR, New London, Conn.
Candee, Elliot E., Dist. Br. For., N Y N H & H R R, Waterbury, Conn.
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Casey, W. W., For. B. & B., K. C. S. Ry., Texarkana, Texas.
Catchot, A. J., Supvr. B. & B., L. & N. R. R., Ocean Springs, Miss.
Cayley, W., Supvr., G. T. Ry., Stratford, Ont.
Clark, H. W., Supv. B. & B., Mo. Pac. R. R., Atchison, Kans.
Clark, J. H., M. of W. Clerk, Sou. Pac. Co., Tucson, Ariz.
Clark, W. A., Chief Engr., D. & I. R. R. R., Duluth, Minn.
Clopton, A. S., Supvr. B. & B., M. K. & T. Ry., Oklahoma City, Okla.
Clothier, E. E., Chief Carp., C. M. & St. P. Ry., Mobridge, So. Dak.
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Cole, J. E., Gen'l Inspr., Sou. N. E. Ry., Providence, R. I.
Collings, Edwd., Chief Carp., C. M. & St. P. Ry., Perry, Iowa.
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Copp, J. P., Roberts & Schaeffer Co., McCormick Bldg., Chicago.
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Cota, G. M., Ch. Clerk, Eng. Dept., C. Vt. Ry., St. Albans, Vt.
Counts, D. E., Supv. B. & B., W. & A. R. R., Dalton, Ga.
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Crawford, J. A., B. & B. Master, C. N. Ry., Saskatoon, Sask.
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Cullen, J. F., For. B. & B., O. S. L. R. R., Pocatello, Idaho.
Cummin, Joseph H., Brightwaters, N. Y.
Cunningham, A. O., Chief Engr., Wabash R. R., St. Louis, Mo.
Curry, Jno., For. B. & B., Mo. Pac. R. R., McGehee, Ark.
Curtin, William, Contractor, Govan, Saskatchewan.

Dale, Chas., For. W. S., I. C. R. R., New Orleans, La.
Dalstrom, O. F., Bridge Engr., C. & N. W. Ry., Chicago.
Danes, E. C., Gen. For., Wabash R. R., Peru, Ind.
Decker, H. H., Contractor, 2915 Ingersoll Ave., Des Moines, Ia.
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Derr, W. L., Supt., C. G. W. R. R., Clarion, Iowa.
de Ximeno, A., C. C. S. Corp., Obispo 59, altos, Havana, Cuba.
Dickerson, O. H., Prin. Asst. Engr., D. & I. R. R. R., Duluth, Minn.
Dickson, Geo., For. Brdgs., Sou. Pac. Co., Oakland, Cal.
Dickson, G. H., Asst. Engr., B. & B., T. & N. O., Ry., North Bay, Ont.
Dillabough, J. V., Asst. Dist. Engr., C. N. Ry., Edmonton, Alta.
Dittmar, F. C., Br. For., Sou. Pac. Co., Los Angeles, Cal.
Dodd, A. M., Supv. B. & B., C. of Ga. R. R., Macon, Ga.
Donaldson, C. E., Actg. G. F. B. & B., C. Vt. R. R., St. Albans, Vt.
Douglas, L. H., Mast. Carp., B. & O. R. R., Cleveland, O.
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Total number of members 709.

Total No. of Members, Jan. 1, 1918,		709
Died,	11	
Resigned and dropped,	23	34
No. members Oct. 14, 1918,		675
New members Oct., 1918,		48
Total members Oct. 20, 1918,		723

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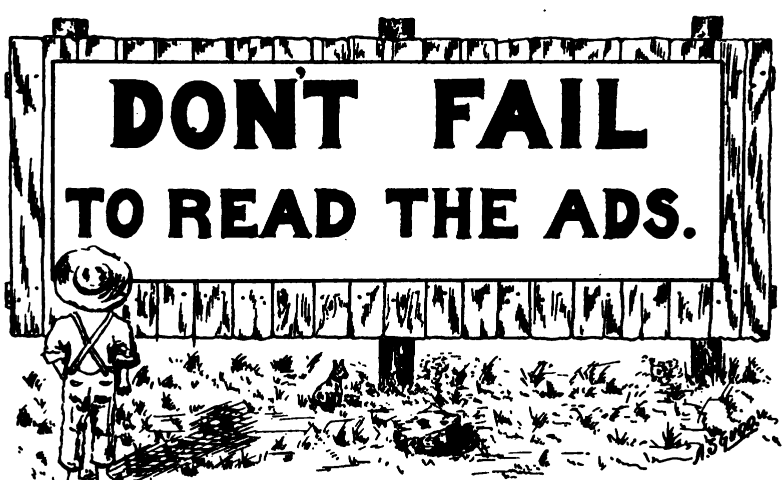
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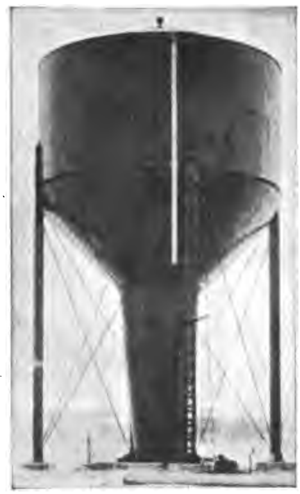

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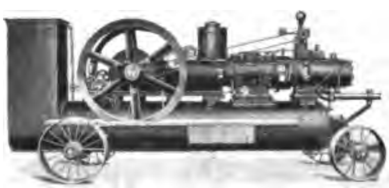

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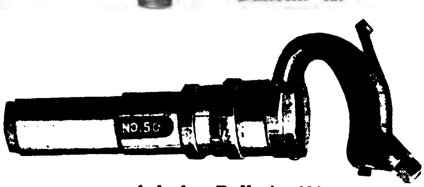
Portable Compressors

ball bearing type, used the world over for drilling, wood boring, reaming, tapping, etc. High power, long life, and economical upkeep and air consumption are features through which " Little Giant " Air Drills have become justly famous. Available in a complete line embracing all air drilling requirements.



Ask for Bulletin 124

Boyer Hammers

Boyer Pneumatic Hammers enjoy the reputation of being the hardest hitting, easiest to operate, most economical and simple pneumatic hammers made. The recognized standard of pneumatic hammer users for over 25 years. Made in a variety of sizes for riveting, chipping, sealing, etc.

Chicago Pneumatic Tool Company

Fisher Building

New York **CHICAGO** **San Francisco**

Sales Offices All Over the World

CHICAGO PNEUMATIC PRODUCTS

Pneumatic Tools
Electric Tools
Air Compressors
Oil and Gas Engines
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"CHICAGO PNEUMATIC"

Depend Upon That Name

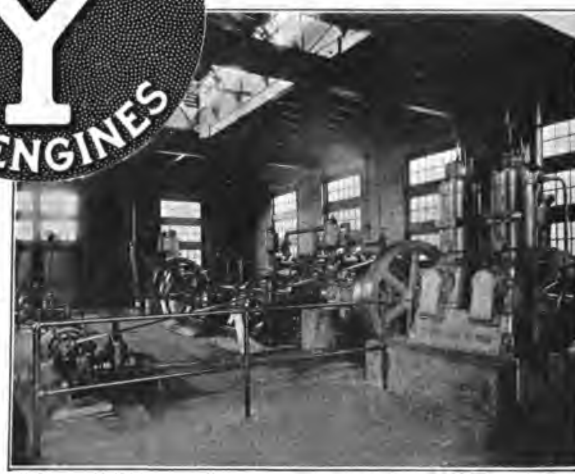
Valves to 24 inch

Valves up to 24 inches

Water Pressure Regulating
Valves to 24 inch

FAIRBANKS-MORSE
10 TO 200 H.P.
"Y"
OIL ENGINES

Unfailing Power *from* Low Priced Fuel Oils



Pumping Station on the "Southern" at Monroe, Va.

Constant Dependable Service

is assured wherever "Y" Oil Engines are installed. They run steadily, smoothly, with little attention. Low upkeep and low maintenance costs.

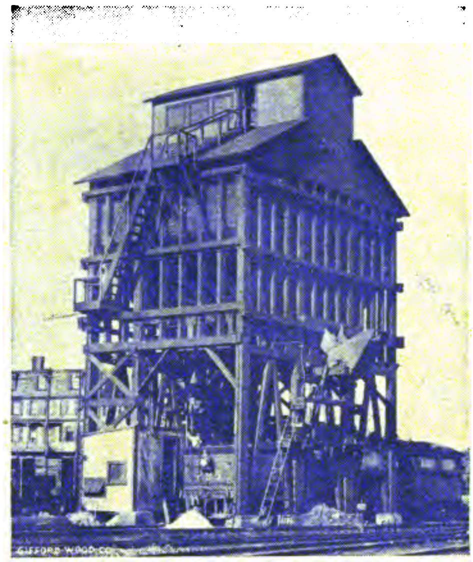
The picture shows two 75 H. P. Type "Y" Engines direct connected to two 13" x 12" plunger and ring pattern power pumps and belted to two 8" centrifugals.

All Equipment Guaranteed by Fairbanks-Morse Quality

FAIRBANKS, MORSE & CO.
Chicago - *Manufacturers*

Engines, Pumps, Motors, Railway Supplies, Scales, Water Systems Lighting Plants, Hoists, Air Compressors, etc.

Locomotive Coaling Stations



For Handling Coal, Ashes and Cinders

Coaling Station Equipment

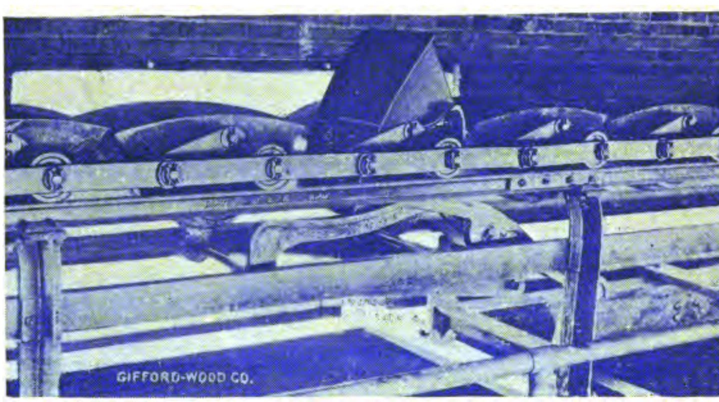
designed for

Quick Handling* and *Long Service

The dependability of Gifford-Wood equipment has led the following representative railroad companies to adopt our equipment:

New York Central R. R.
Canadian Pacific Ry.
Boston and Albany R. R.
Boston and Maine R. R.
Rutland Railroad
Ottawa and New York R. R.
Chicago, W. Pullman and South. R. R.

Write for Catalog



Power Plant Coal Handling Equipment

(OVER) Catalogs

Gifford-Wood Co.

***Chicago Office:* 565 W. Washington St.**

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HUDSON, N. Y.

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ROOFING THRIFT

The new thrift way to re-roof is to lay NEPONSET Paroid, red or green slate surfaced, or the ART-CRAFT roof right over old wooden shingles.

Above is a picture of the ART-CRAFT Roof being applied over old wooden shingles on the Rock Island Station at 91st Street, Chicago, Ill.

Bird & Son
Incorporated
ESTABLISHED 1795
Chicago New York
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NEPONSET
PRODUCTS
Trade Mark
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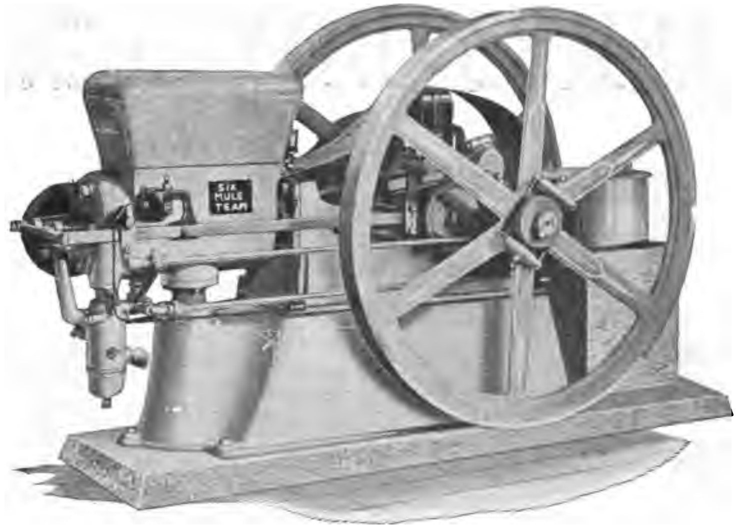
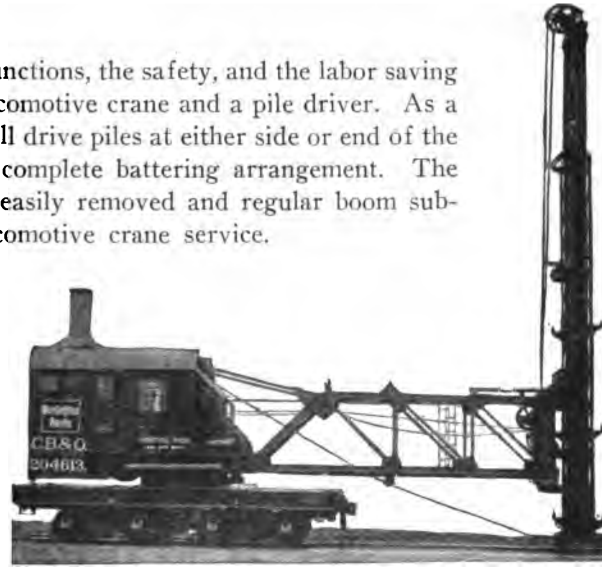

SIX
MULE
TEAM

B
CANT FREEZE
A

An INDUSTRIAL WORKS
Convertible Crane Pile Driver

combines the functions, the safety, and the labor saving abilities of a locomotive crane and a pile driver. As a pile driver it will drive piles at either side or end of the car. It has a complete battering arrangement. The leader truss is easily removed and regular boom substituted for locomotive crane service.



Industrial Works
Bay City, Mich.

Locomotive and Wrecking Cranes, 5 to 160 tons capacity, Pile Drivers Transfer Tables, Pillar Cranes, Railsaws, Transfer Cranes Steam Hammers, Grab Buckets

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THE COLUMBIAN STEEL MAIL CRANE

THE COLUMBIAN has proved to be the most satisfactory mail crane in the world. It is built entirely of steel and malleable iron. No tubing used in the principal construction. The steel bars make every part of the crane accessible to the paint brush.

Over one half of all the cranes in use on the American Continent are COLUMBIANS

The Columbian is used exclusively by all the leading roads in Canada, including the government lines. Has been in active service 24 years.

We also manufacture MAIL CATCHERS of the very latest design at a reasonable cost. Recommended by the Post Office department.

We are always prepared to make prompt shipments of Mail Catcher Rubber Bumpers. Write for Catalog and prices.

Columbian Mail Crane Co. Columbus, Ohio